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Museum Victoria undertakes research in order to contribute to a deeper understanding and appreciation of the origins, diversity and development of Australia's natural, cultural and scientific heritage, and applies this knowledge for the benefit of society. The Museum publishes its scientific journal *Memoirs of Museum Victoria* (until 1983 *Memoirs of the National Museum of Victoria*) to further these objectives.

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Final manuscripts (prior to papers being refereed) and accompanying illustrations must be submitted to the editor **no later than 1 August**. Earlier submission is encouraged.

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Papers must be submitted to the editor in final manuscript form as a **word document file only** and double line spaced. Any accompanying images or drawings must be submitted separately and NOT embedded within the text.

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An outline of the required **format and style guide** is supplied here, however, authors should also refer to the previous edition of *Memoirs of Museum Victoria* for a more in depth guide.

No fonts other than Times must be used.

Papers should be arranged as follows:

title (including higher classification of zoological taxa)

authors' name and address (postal and email)

abstract

key words

contents (only if the paper is extensive)

introduction

main text

acknowledgements

references

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Author's **email addresses** in contact details should be in brackets.

Primary **headings** are in bold and left justified; secondary headings in italics and left justified. Italics in the text should otherwise be restricted to generic and specific names. **Paragraphs** are indented. **Measurements** must be in the metric system (SI units).

Abbreviation of River and Island/s: Use R for River. Use I for Island and Is. for Islands.

For **numbers**, use **numerals except** when used in text narrative when they should be spelt out, but only up to and including the number ten. Numerals should also be spelt out when used as follows: first, second, third, fourth, tenth, twentieth etc.

The word **Figure** should be spelt out when used below a genus name in the body of the text and in the Figure caption. However, when figures are referred to within the text do not spell out and instead use fig. or figs.

Captions to illustrations must be submitted separately at the end of the manuscript and should follow this example:

Figure 1. *Storhyngurella hirsuta* sp. nov., male, holotype: a, b, dorsal and lateral views of body; c, d, frontal and lateral views of cephalon.

References should be listed alphabetically at the end of the manuscript. Journal and book titles must be in full and italicised, with the year of publication, edition, page number, publisher and city of publication in roman. Authors should follow this example:

Paulin, C.D. 1986. A new genus and species of morid fish from shallow coastal waters of southern Australia. *Memoirs of Museum Victoria* 47: 201–206.

Last, P.R., and Stevens, J.D. 1994. *Sharks and rays of Australia*. CSIRO Publishing: Melbourne. 513 pp.

Wilson, B.R., and Allen, G.R. 1987. Major components and distribution of marine fauna. Pp. 43–68 in: Dyne, G.R. and Watson, D.W. (eds), *Fauna of Australia Volume 1A General articles*. Australian Government Publishing Service: Canberra.

Reference citations should use the following style:

Paulin, 1986; Last and Stevens, 1994; Smith et al., 1990.

In **taxonomic** papers synonymies should be of the form: taxon, author, year, pages, figures. A period and dash must separate taxon and author except in the case of reference to the original description, e.g. *Leontocaris* Stebbing, 1905: 98–99.—Barnard, 1950: 699.

Supplementary information (extended lists of material examined, databases etc) should be submitted separately and with the final manuscript to be forwarded to referees. The Editorial Board encourages use of supplementary information to minimise the cost of printing as long as the requirements of the International Code of Zoological Nomenclature are met in the printed paper.

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Australian species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae)

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Abstract

O'Loughlin, P.M. and Maric, D. 2008. Australian species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 65: 1–22.

Six new species of *Psolidium* Ludwig from Australia are described: *Psolidium berentsae*, *P. hutchingsae*, *P. karenae*, *P. laperousazi*, *P. marshae*, *P. mcallumae*. The species *Psolus parmatius* Sluiter and *Psolus spinuliferus* H. L. Clark are re-assigned to *Psolidium*. Diagnoses are given for *Psolidium granuliferum* H. L. Clark, *P. nigrescens* H. L. Clark, *P. minutus* (H. L. Clark), *P. parmatius* (Sluiter), *P. ravum* Hickman and *P. spinuliferus* (H. L. Clark). The family Psolidae is ascribed to Forbes as author, not Perrier. The diagnosis of the family Psolidae, assignment of genera, and status of the family are discussed. The genus *Psolidium* is revised. Keys are provided to the genera of Psolidae, and 12 known Australian species of *Psolidium*.

Keywords

Echinodermata, Holothuroidea, Psolidae, *Psolidium*, taxonomy, new species, keys.

Introduction

Rowe (in Rowe and Gates, 1995) listed four species of *Psolidium* Ludwig, 1886 from Australia: *P. granuliferum* H. L. Clark, 1938 (southern Western Australia), *P. minutus* (H. L. Clark, 1938) (Lord Howe I), *P. nigrescens* H. L. Clark, 1938 (New South Wales), and *P. ravum* Hickman, 1962 (Tasmania). *Psolus spinuliferus* H. L. Clark, 1938 was described for northwestern Australia, and is re-assigned here to *Psolidium*. *Psolus parmatius* (Sluiter, 1901) was described for Indonesia, and was found recently in collections from the continental slope off Western Australia. It is also re-assigned here to *Psolidium*. In this work six new species of *Psolidium* are described for Australia.

Pawson and Fell (1965), and subsequent authors, have incorrectly nominated Perrier (1902) as the systematic author of the Psolidae. Forbes (1841) was the original author.

Materials and methods

Live colour photographs of some species were taken in the field by Karen Gowlett-Holmes, and the images lodged in the South Australia Museum with a photoindex registration prefix PK. Some specimen photographs were taken by Leon Altoff and Audrey Falconer, with Mark O'Loughlin, using a Pentax K10D digital SLR with a variety of lenses and lit using two electronic flashes. Preserved specimens were placed on or suspended

above black velvet. The live photo was taken in a perspex tank with filtered sea water. Photos of ossicles were taken by Mark O'Loughlin and Chris Rowley using a Leica DM5000 B compound microscope, and Leica DC500 camera with montage software. Some specimen photographs were taken by Simon Hinkley with Dragica Maric using a Leica MZ16 stereomicroscope, Leica DC500 digital camera with montage software. Drawings of tube feet distributions were made by Dragica Maric using stereomicroscope and camera lucida.

Abbreviations: AM—Australian Museum, Sydney; MCZ—Museum of Comparative Zoology, Harvard, USA; NMV—Museum Victoria, Melbourne, Australia; SAM—South Australian Museum, Adelaide; WAM—Western Australian Museum, Perth; ZMA—Zoölogisch Museum, Amsterdam.

Specimen registration number prefixes: AM J, NMV F, SAM K, WAM Z, ZMA V.ECH.H

Dendrochirotida Grube, 1840

(restricted Pawson and Fell, 1965)

Key to genera of Psolidae Forbes

1. Dorsal and lateral scales imbricating, conspicuous, lacking calcareous towers; scales of ventro-lateral body clearly demarcated from the thin calcareous sole that lacks scales **2**

- Dorsal and lateral multilayered ossicles (scales) embedded in integument; some scales with conspicuous projecting calcareous towers; ventro-lateral body not clearly demarcated from sole *Echinopsolus* Gutt, 1990
- 2. Tentacles 15; oral valves 5, radially situated *Ceto* Gistel, 1848
- Tentacles 10; oral valves situated interradially if present **3**
- 3. Mid-body tube feet absent dorsally and laterally *Psolus* Oken, 1815
- Mid-body tube feet present dorsally and laterally **4**
- 4. Dorsal and lateral scales covered by ossicles that include hour-glass shaped and/or tower ossicles *Lissothuria* Verrill, 1867
- Hour-glass shaped and tower ossicles not present amongst the dorsal and lateral ossicles **5**
- 5. Mouth and anus lie in the plane of bilateral symmetry *Psolidium* Ludwig, 1886
- Mouth and anus lie in a plane at right angle to the usual plane of bilateral symmetry *Ekkentropelma* Pawson 1971b

Psolidae Forbes

(synonymy of systematic records)

Psolidae Forbes, 1841: 201–02, 206.—Agassiz, 1845: 11.—Agassiz, 1848: 905.

“Psoline sub-family” Bell, 1882: 642 (no family or other sub-family nominated).

Psolida (uncredited).—Haeckel, 1896: 380, 441, 442.

Psolinae R. Perrier, 1902: 493, 512 (sub-family of Cucumariidae, with Cucumariinae).

Psolidae Perrier, 1902.—Pawson and Fell, 1965: 4.—Pawson, 1969a: 129.—Pawson, 1968b: 19.—Pawson, 1968c: 347.—Tommasi, 1969: 8.—Pawson, 1970: 28.—Pawson, 1971a: 33–34.—Pawson, 1971b: 115, 118.—Tommasi, 1971: 3–4.—Pawson and Valentine, 1981: 450.—Carriol et Féral, 1985: 50.—Gutt, 1988: 22–23.—Gutt, 1990: 112–13.—Massin, 1992a: 317.—Massin, 1992b: 179.—Lambert, 1996: 21.—Massin, 1997: 101.

Psolidae Ed. Perrier (undated).—Thandar, 2006: 35 (R. Perrier was the author of Psolinae).

Psolidae (uncredited).—Mortensen, 1927: 413.—Deichmann, 1940: 206.—Deichmann, 1941: 73, 135–36.—H. L. Clark, 1946: 385, 412–13.—Deichmann, 1947: 336.—Deichmann, 1954: 401.—Hickman, 1962: 60.—Pawson, 1964: 461–62.—Pawson, 1967: 1–2.—Baranova and Belyaev, 1968: 236.—Pawson, 1968a: 142.—Pawson, 1969b: 38, maps 3, 5.—Cherbonnier, 1974: 601, 605.—Dartnall, 1980: 13, 77.—Pawson, 1982: 815.—Cannon and Silver, 1987: 10, 11, 29.—Rowe (in Rowe and Gates), 1995: 317.

Diagnosis (most recently by Lambert, 1996, quoting Pawson, 1970). Body flattened, with well-defined ventral sole. Dorsal surface of body invested by imbricating scales. Ventral sole soft, surrounded by tube feet. Mouth and anus dorsally turned.

Type genus. *Psolus* Oken, 1815 (original designation; = *Lepidopsolus* Bronn, 1860, and *Lophothuria* Verrill, 1866; synonymy by Théel, 1886).

Other genera. *Ceto* Gistel, 1848 (= *Cuvieria* Jäger, 1833, *Callisto* Gistel, 1848, *Stolinus* Selenka, 1868, *Hypopsolus* Bell, 1882, and *Theelia* Ludwig, 1892; synonymy by Pawson, 1971a); *Lissothuria* Verrill, 1867 (= *Thyonopsolus* H. L. Clark, 1901; synonymy by Pawson, 1967); *Psolidium* Ludwig, 1886; *Ekkentropelma* Pawson, 1971b; *Echinopsolus* Gutt, 1990.

Remarks. The family Psolidae was erected by Forbes (1841), who based his family on the genus *Psolus* Oken and remarked that *Cuvieria* Peron (= *Ceto* Gistel, by Pawson, 1971a) should be included in Psolidae. The family was recognised by Agassiz (1845, 1848). Bell (1882) referred to a “Psoline sub-family”, without reference to family or additional sub-family. Perrier (1902) erected 2 sub-families for Cucumariidae: Cucumariinae and Psolinae. Subsequently no author (including Perrier himself) has referred to Psolinae Perrier, 1902. Perrier (1905), Mitsukuri (1912), and Ohshima (1915) referred species of *Psolidium* Ludwig, 1886, and *Psolus* Oken, 1815, to Cucumariidae, without reference to Psolidae. Mortensen (1927) referred *Psolus* and *Psolidium* species to Psolidae, without indication of family author. Many authors followed Mortensen (1927). Pawson and Fell (1965) incorrectly nominated Perrier (1902) as the systematic author of the Psolidae. Subsequent authors incorrectly referred to Psolidae Perrier, 1902.

Within the history of holothuroid classification we note that Semper (1868) referred *Psolus* Oken to order II Pneumonophora, family Dendrochirotae, sub-family Dendrochirota Gastropoda. Théel (1886) referred *Psolus* Oken to order II Pedata, family Dendrochirotae, sub-family Gastropoda.

Forbes (1841) distinguished the family Psolidae as “having a soft circumscribed disk like the foot of a Gasteropodous Mollusc on which the suckers are placed for progression”. In his diagnosis of sub-family Psolinae, Perrier (1902) continued emphasis on the distinct sole with its specialised tube feet. Mortensen (1927) added the presence of large imbricating scales dorsally, sharply delimited from the thin-walled ventral sole; dorsal mouth and anus; and 10–15 tentacles. Subsequent diagnoses by Deichmann (1941), Hickman (1962), Pawson and Fell (1965), Tommasi (1969, 1971), Pawson (1970, 1982), Carriol et Féral (1985), Cannon and Silver (1987), Gutt (1988), Rowe (in Rowe and Gates, 1995), and Lambert (1996) have generally agreed with Mortensen (1927). But none has continued to include the significant point made by Mortensen (1927) that there is a sharp demarcation between the dorsal scales and the thin-walled sole. In discussing his new genus *Psolidiella*, Mortensen (1925) noted “a distinct ventral sole, which is, however, not limited from the rest of the body by a sharp edge”, one reason given by Mortensen for not referring *Psolidiella* to the Psolidae.

A second reason stated by Mortensen (1925) for not referring *Psolidiella* to the Psolidae was “the fact that the posterior part of the intestine, with its mesentery, is in the left ventral interradius”. He added “the situation of the posterior part of the intestine appears to be of primary importance for the subdivision of dendrochirotes, the cucumariids and the phyllophorids having it in the left, and the psolids having it in the right ventral interradius”.

Hickman (1962) noted contradictory observations by Deichmann (1941) who claimed that “Cucumariidae seem typically to have the third mesentery attached on the right side of the midventral muscle band, the Phyllophoridae seem to have it attached to the left, and the Psolidae have it either way”. She explained that for *Psolidium* and *Thyonopsolus* (= *Lissothuria*) the loop is attached in the left ventral interambulacrum, while in *Psolus* it is attached in the right.

Some cucumariid species were examined in this study: *Apsolidium densum* O’Loughlin and O’Hara, 1992, *Neoamphicyclus mutans* (Joshua, 1914), *Psolidiella hickmani* O’Loughlin, 2000. In these three cucumariid genera and species the posterior intestinal mesentery is attached to the left of the midventral radial muscle, supporting Mortensen (1925) and contradicting Deichmann (1941). O’Loughlin (2000) illustrated this position for the genus *Psolidiella*. Pawson (1968a) described a right attachment for the cucumariid species *Pseudopsolus macquariensis* (Dendy, 1896), and Ludwig and Heding (1935) reported a right attachment for their cucumariid species *Pseudocholchirus mollis*, supporting Deichmann (1941). This evidence indicates that the position of posterior intestinal mesenteric attachment is variable for cucumariids as currently assigned.

Some psolid species were examined in this study: *Ceto cuvieria* (Gistel, 1848), *Echinopsolus acanthocola* Gutt, 1990, *Psolidium poriferum* (Studer, 1876) (= *incertum*), *Psolidium ravum* Hickman, 1962, *Psolus antarcticus* Philippi, 1857, *Psolus arnaudi* Chéronnier, 1974, *Psolus charcoti* Vaney, 1906, *Psolus koehleri* Vaney, 1914, *Psolus paradubiosus*

Carriol and Féral, 1985. In eight of these psolid species the posterior intestinal mesentery is attached to the right of the midventral radial muscle, supporting Mortensen (1925) and Deichmann (1941) for *Psolus* species. But in *Ceto cuvieria* it is attached to the left. This evidence indicates that the position of posterior intestinal mesenteric attachment is variable for psolids as currently assigned.

Pawson (1967) noted difficulty with the Psolidae in determining whether or not some species should be considered psolids or referred to another dendrochirotid family. The cucumariid genera *Pseudopsolus* (see Pawson, 1968a), *Apsolidium* and *Neocnus* (see O’Loughlin and O’Hara, 1992), and *Psolidiella* (see O’Loughlin, 2000) include species with a sole that is not delimited by a distinct junction of ventro-lateral body wall scales with a thin-walled sole lacking scales, and lack conspicuous imbricating dorsal and lateral scales. None has been referred to Psolidae. We support this exclusion. The genus *Echinopsolus* Gutt, 1990 was referred to Psolidae on the grounds of the species having a distinct sole. We note that *Psolus charcoti* Vaney, 1906 and *Echinopsolus acanthocola* Gutt, 1990 lack a sharply demarcated sole, and lack macroscopic imbricating scales dorsally, and should not be referred to Psolidae. Reassignment of these taxa does not belong in this revision of *Psolidium*, and will be treated elsewhere.

A comprehensive revision of the relationships amongst cucumariid and psolid species is required and should be undertaken with supportive evidence from molecular genetic data.

Table 1. Distribution of Australian species of *Psolidium* Ludwig, 1886.

<i>Psolidium</i> species	Distribution
<i>P. berentsae</i> sp. nov.	Queensland, Lizard I, 6–18 m
<i>P. granuliferum</i> H. L. Clark, 1938	SW Western Australia to SE Tasmania, 4–37 m
<i>P. hutchingsae</i> sp. nov.	Northern New South Wales, 12–15 m
<i>P. karenae</i> sp. nov.	South Australia, 3–12 m
<i>P. laperosazi</i> sp. nov.	SE Tasmania to South Australia, 1–10 m
<i>P. marshae</i> sp. nov.	Western Australia to South Australia, 5–14 m
<i>P. mccallumae</i> sp. nov.	Western Australia, off Point Cloates, 100 m
<i>P. minutus</i> (H. L. Clark, 1938)	Eastern Tasman Sea, 1–10 m
<i>P. nigrescens</i> H. L. Clark, 1938	NSW, Broken Bay to Batemans Bay, 0–11 m
<i>P. parmatus</i> (Sluiter, 1901)	Indonesia to NW Western Australia, 95–487 m
<i>P. ravum</i> Hickman, 1962	SE Tasmania to W South Australia, 0–15 m
<i>P. spinuliferus</i> (H. L. Clark, 1938)	NW Australia, Darwin to Perth, 0–22 m

Key to Australian species of *Psolidium* Ludwig

1. Dorsal and lateral scales with vertical spires/pillars (not lumps) **2**
 - Dorsal and lateral scales lacking spires/pillars; some species with surface lumps on the scales **3**
2. Dorsal and lateral scales each covered with slightly bulbous pillars; lacking mid-ventral radial series of tube feet; “thorn” ossicles present in body wall *P. parmatus* (Sluiter, 1901) (NW Australia slope)
 - Dorsal and lateral scales with predominantly single digitiform spires; mid-ventral radial series of tube feet present; lacking “thorn” ossicles in body wall *P. spinuliferus* (H. L. Clark, 1938) (N and W Australia)
3. “Thorn” ossicles present in body wall; live and preserved colour “black” *P. nigrescens* H. L. Clark, 1938 (central New South Wales)
 - Body wall lacking “thorn” ossicles; live and preserved colour not “black” **4**
4. Body wall with cupped crosses and/or cups **5**
 - Body wall lacking cupped crosses and/or cups **11**
5. Cupped crosses and/or cups in sole of 2 ranges of size ... **6**
 - Cupped crosses and/or cups in sole of 1 range of size **7**
6. Rosettes present in dorsal body wall and tentacles; smaller cupped crosses and cups up to 32 μm long; sole with irregular thick perforated plates, knobbed on surface and margin *P. marshae* sp. nov. (SW Australia)
 - Rosettes absent from dorsal body wall and tentacles; smaller cupped crosses and cups up to 24 μm long; sole with smooth perforated plates *P. minutus* (H. L. Clark, 1938) (E Tasman Sea)
7. Dorsal and lateral cups shallow, completely covered by fine spinelets, including the cross; lacking mid-ventral radial series of tube feet *P. mccallumae* sp. nov. (Western Australia slope)
 - Dorsal and lateral cups and cupped crosses not shallow; spinelets on rim of cup or distally on branches of cupped cross, not on cross; mid-ventral radial series of tube feet present **8**
8. Body wall with predominantly cups, fewer cupped crosses **9**
 - Body wall with predominantly cupped crosses, fewer cups **10**
9. Knobbed plates in sole; tentacle rosettes small, up to 40 μm long; body rounded ventrally in transverse section *P. berentsae* sp. nov. (NE Queensland)
 - Perforated plates in sole predominantly smooth; tentacle rosettes large, up to 80 μm long; body flat ventrally *P. laperousazi* sp. nov. (SE Australia)
10. Knobbed perforated plates in sole; irregular perforated plates in tentacles *P. hutchingsae* sp. nov. (N New South Wales)
 - Perforated plates in sole predominantly smooth; tentacles lack irregular perforated plates *P. ravum* Hickman, 1962 (SE Australia)
11. Lacking series of mid-ventral radial tube feet; dorsal and lateral tube feet inconspicuous in mid-body; dorsal and lateral scales coarsely granuliform *P. granuliferum* H. L. Clark, 1938 (southern Australia)
 - Mid-ventral radial tube feet present as scattered series; dorsal and lateral tube feet conspicuous in mid-body; dorsal and lateral scales finely granuliform *P. karenae* sp. nov. (South Australia)

***Psolidium* Ludwig**

Figures 1e, 2d, 4b-d, 5e, 8f

Psolidium Ludwig, 1886: 9.—Mortensen, 1927: 413.—Deichmann, 1941: 141-143.—Deichmann, 1947: 336.—Lambert, 1996: 21.

Diagnosis. Dendrochirotid holothuroids; small, up to 40 mm long; mid-body arched dorsally in transverse section, flat ventrally; dorsal and lateral body covered with imbricating scales, usually macroscopically conspicuous, sometimes obscured by integument, scales irregular in size and arrangement; scales decreasing in size ventro-laterally, orally and anally; lacking large oral valves; extensible oral cone, anterior or anterior-dorsal or dorsal orientation; extensible anal cone, posterior or posterior-dorsal or dorsal orientation; tube feet dorsally and laterally in mid-body, pass through scales.

Sole distinct, oval to elongate; discrete margin created by junction of small imbricating ventro-lateral scales with thin-walled, usually calcareous sole that lacks scales; peripheral band of tube feet, may be discontinuous across the inter-radii anteriorly and posteriorly; peripheral tube feet frequently of 2 sizes, those of outer series smaller; mid-ventral radial series of tube feet present or absent.

Calcareous ring solid, plates sub-rectangular, radial and interradial plates with tapered anterior projections; radial plates with deep notch posteriorly, interradial plates with shallow concave indentation posteriorly; 10 dendritic tentacles, ventral 2 smaller.

Dorsal and lateral ossicles: multi-layered or single-layered perforated plates (scales), always some with tube foot canals; integument covering scales may have cupped crosses, cups, “thorn” ossicles (irregular branched rods pointed distally), buttons, perforated plates and rosettes; tube foot small endplates, and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Sole ossicles: inter-radii with small to large single-layered perforated plates (rarely with multi-layering), smooth to variably knobbed and thickened, sometimes with cupped crosses, cups, thorn ossicles and rosettes; radii with additional tube foot ossicles, large endplates and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

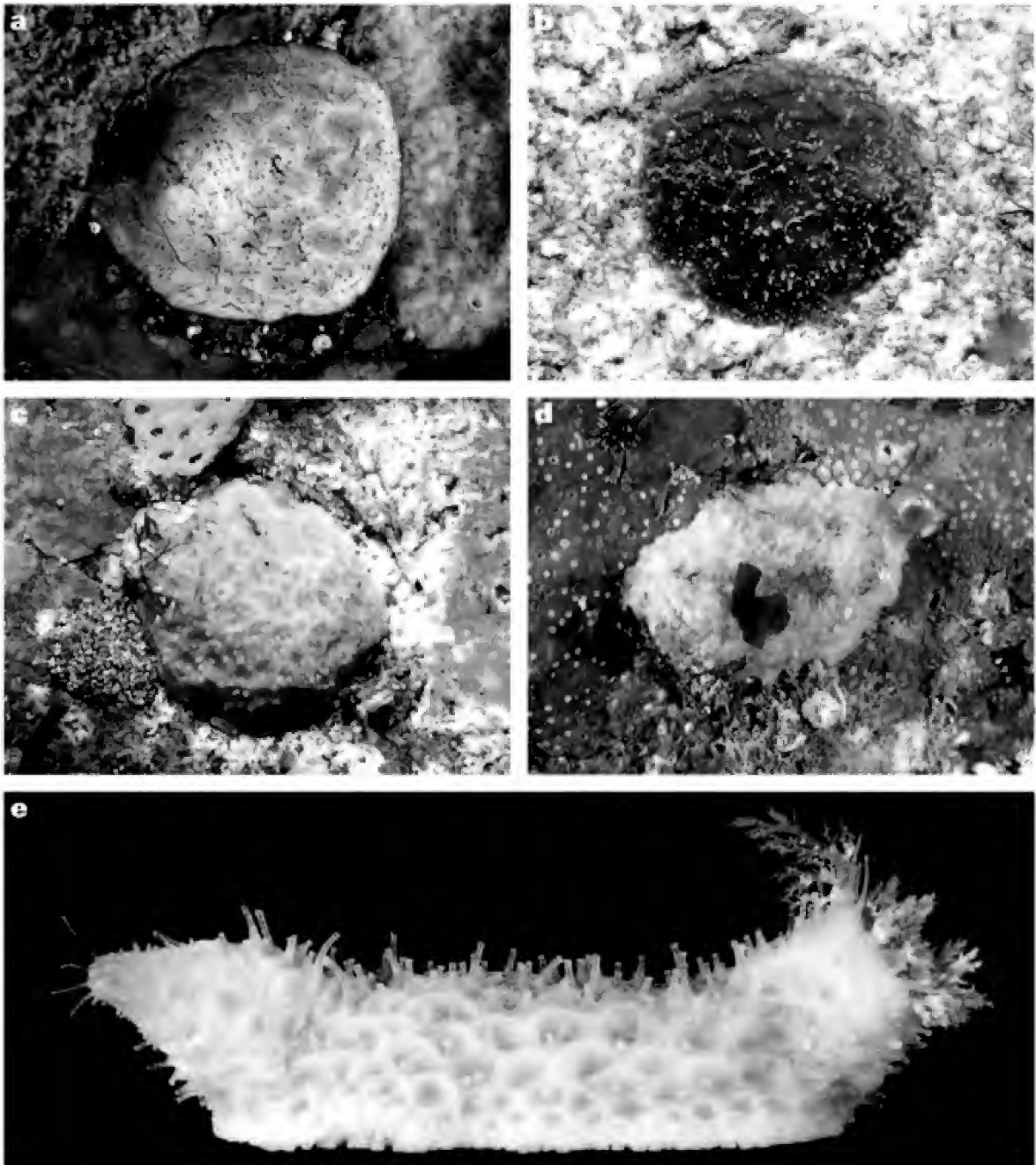


Figure 1. Photos of live specimens of *Psolidium* Ludwig, 1886 (a–d, in situ by K. Gowlett-Holmes; e, in aquarium by L. Altoff): a, *P. granuliferum* H. L. Clark, 1938, Port Davey, Tasmania (14 mm long preserved; SAM K2174, PK0259); b, *P. karenae* sp. nov., Yorke Peninsula, South Australia (17 mm long preserved; holotype SAM K2177, PK0105); c, *P. laperousazi* sp. nov., Kangaroo I, South Australia (13 mm long preserved; paratype SAM K2179, PK0253); d, *P. marshae* sp. nov., Kangaroo I (10 mm long preserved; SAM K2173, PK0273); e, *P. ravum* Hickman, 1962, Portland, Victoria (17 mm long preserved; NMV F125379).

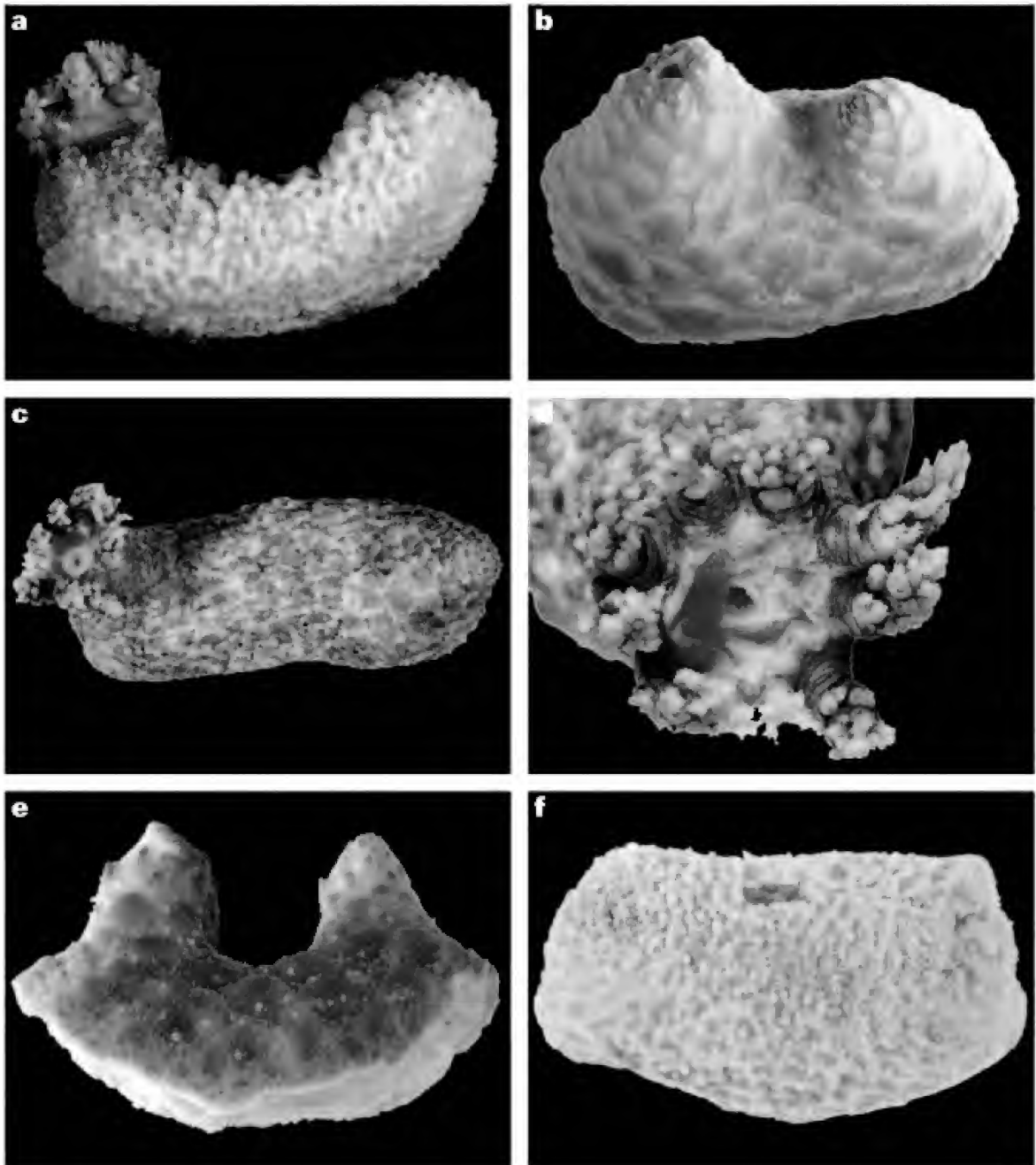


Figure 2. Photos of preserved specimens of *Psolidium* Ludwig, 1886 (a, c–d by L. Altoff; b, e–f by S. Hinkley and D. Maric): a, *P. berentsae* sp. nov., Lizard I, Queensland (lateral view; 12 mm long; holotype AM J24098); b, *P. granuliferum* H. L. Clark, 1938, Smokey Bay, South Australia (dorso-lateral view, with mouth left; 19 mm long; SAM K2176); c–d, *P. hutchingsae* sp. nov., Split Solitary I, New South Wales (20 mm long; holotype AM J24107); c, dorso-lateral view; d, 10 tentacles, with 2 small ventral ones bottom; e, *P. karenae* sp. nov., Adelaide (lateral view, mouth left; 20 mm long; paratype SAM K2185); f, *P. laperousazi* sp. nov., D'Entrecasteaux Channel, Tasmania (dorso-lateral view, mouth right; 18 mm long; paratype SAM K2339).

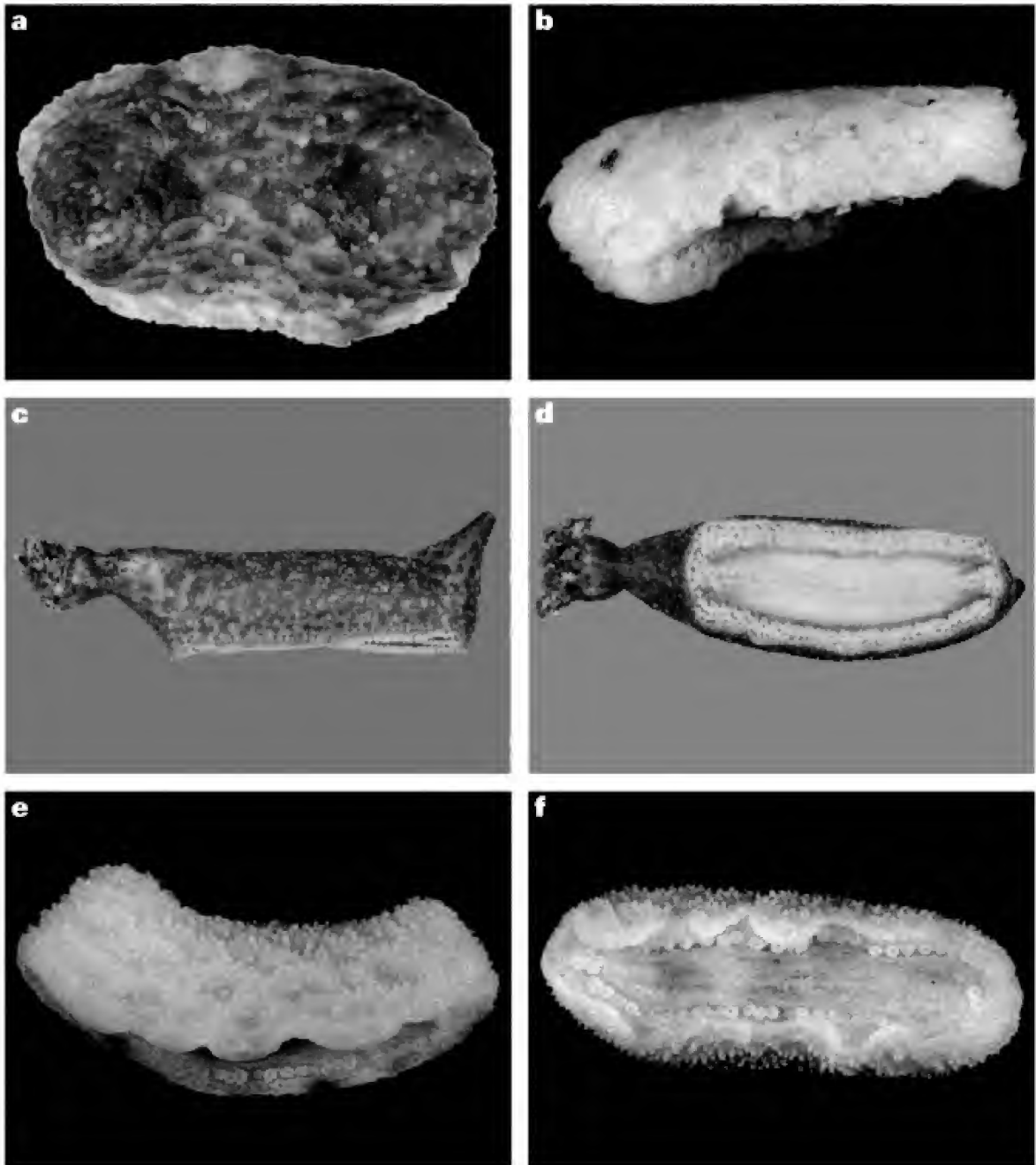


Figure 3. Photos of preserved specimens of *Psolidium* Ludwig, 1886 (by L. Altoff): a, *P. marshae* sp. nov., Geographe Bay, Western Australia (dorsal view; 8 mm long; holotype WAM Z31173); b, *P. mccallumae* sp. nov., slope off Point Cloates, Western Australia (lateral view; 7 mm long; holotype NMV F126891); c–d, *P. nigrescens* H. L. Clark, 1938, Gunnamatta Bay, New South Wales (40 mm long; AM J6821); c, lateral view; d, ventral view (sole); e–f, *P. parmatum* (Sluiter, 1901), Adele slope, Western Australia (9 mm long; NMV F151835); e, lateral view; f, ventral view (sole).

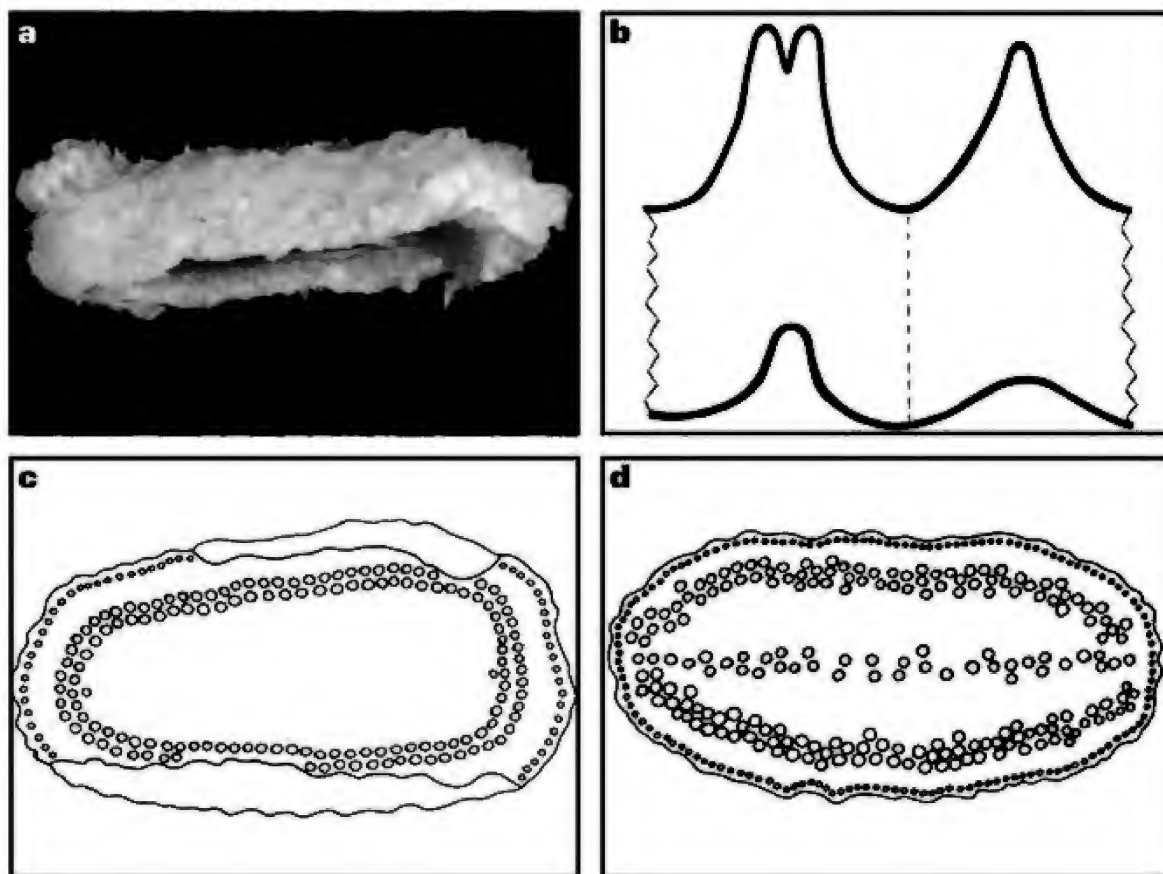


Figure 4. a, *P. spinuliferus* (H. L. Clark, 1938), Darwin (lateral view; 10 mm long; AM J24096; photo by L. Altoff); b, generalised form of radial (left) and interradial plates of the calcareous ring of *Psolidium* species (drawing by M. O'Loughlin); c–d, drawings of sole showing distribution of tube feet (by D. Maric); c, *P. granuliferum* H. L. Clark, 1938 (SAM K2176); d, *P. kareniae* sp. nov. (SAM K2188).

Tentacle ossicles: rods variably perforated, thick to thin, long to short, straight or bent, flat or curved; dendritic tentacle branch endplates are small, irregular in shape, cupped, with a few large perforations and irregular margin; perforated plates may be present; densely branched rosettes may be present.

Type species. *Psolidium dorsipes* Ludwig, 1886.

Australian species. *Psolidium berentsae* sp. nov., *P. granuliferum* H. L. Clark, 1938, *P. hutchingsae* sp. nov., *P. kareniae* sp. nov., *P. laperosazi* sp. nov., *P. marshae* sp. nov., *P. mccallumae* sp. nov., *P. minutus* (H. L. Clark, 1938), *P. nigrescens* H. L. Clark, 1938, *P. parmatus* (Sluiter, 1901), *P. ravum* Hickman, 1962, and *P. spinuliferus* (H. L. Clark, 1938).

Remarks. The descriptive term “thorn” ossicles is used for the body wall ossicles in the form of irregular short branched rods that are pointed distally. They occur in *Psolidium nigrescens* H. L. Clark and *P. parmatus* Sluiter. H. L. Clark (1938) referred

to them as “triradiate particles/spicules”. Sluiter (1901) did not report their presence. The type of *P. parmatus* was examined by one of us (PMO), and their presence noted.

Pawson and Valentine (1981) reported that their Atlantic species *Psolidium prostratum* lacked endplates in the dorsal tube feet. Thandar (2006) described *Psolidium multipes* from South Africa, and among characteristic *Psolidium* features reported that the sole was not distinct from the dorsum, the ventral tube feet were in radial series, and there were multi-layered ossicles in the sole. These characters are atypical of *Psolidium*, but may indicate juvenile form.

The Australian species of *Psolidium* are distinguished from each other in the key. The key indicates three morphological groupings of Australian *Psolidium* species: *P. parmatus* and *P. spinuliferus* and with their vertical pillars/spires on dorsal and lateral scales; species with cupped crosses and cups (as for the type species *P. dorsipes*); and species lacking cupped crosses and cups.

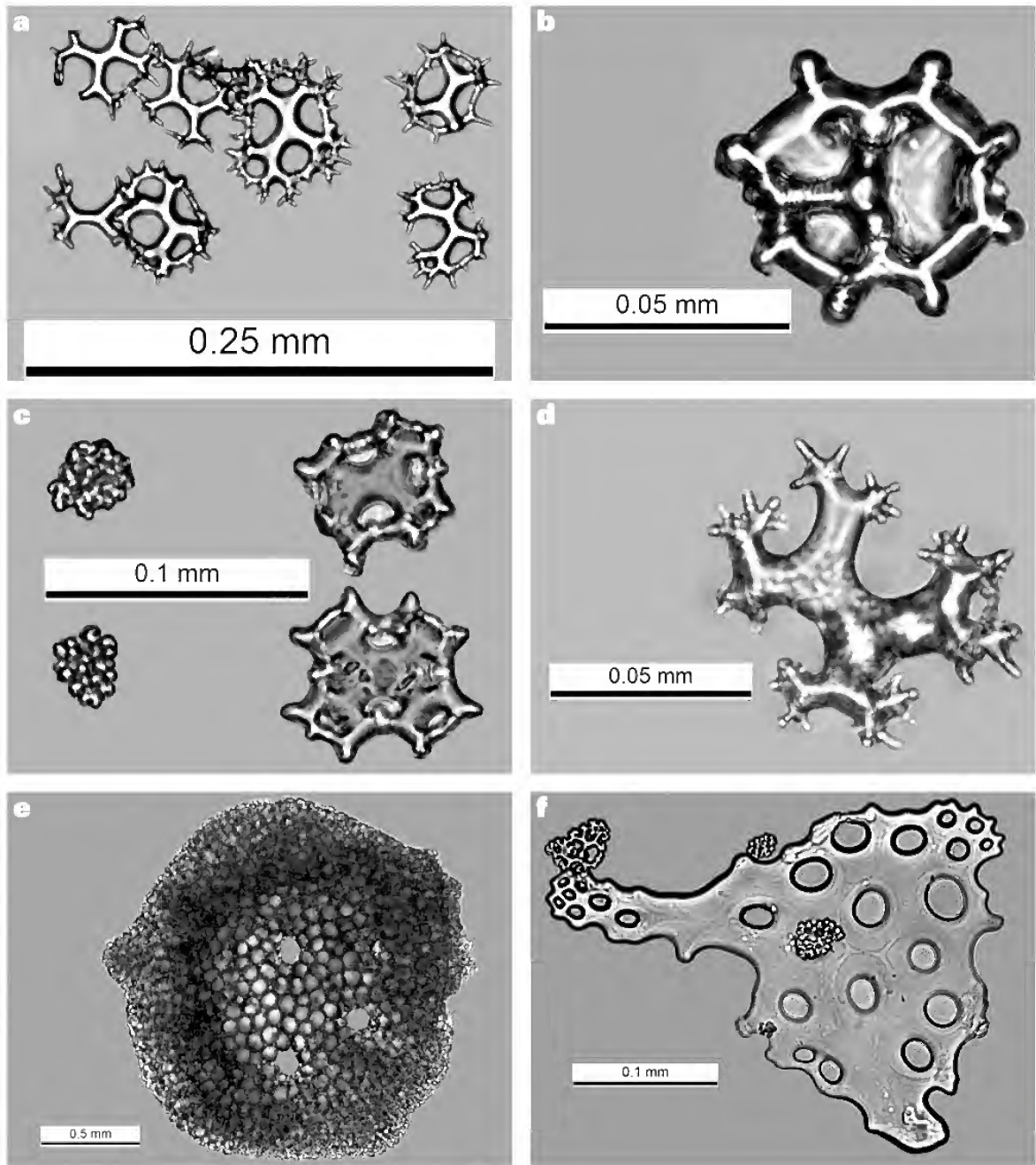


Figure 5. Photos of ossicles from Australian species of *Psolidium* Ludwig, 1886 (by Mark O'Loughlin and Chris Rowley): a–c, *P. berentsae* sp. nov.; a, dorsal cupped crosses and cups (small specimen, paratype AM J24099); b, dorsal bridged cup (holotype AM J24098); c, dorsal cups and rosettes (holotype AM J24098); d–f, *P. hutchingsae* sp. nov.; d, dorsal cupped cross (paratype AM J24108); e, dorsal multi-layered ossicle (scale) with tube foot canals (AM J19665); f, tentacle plate and rosettes (AM J19665).

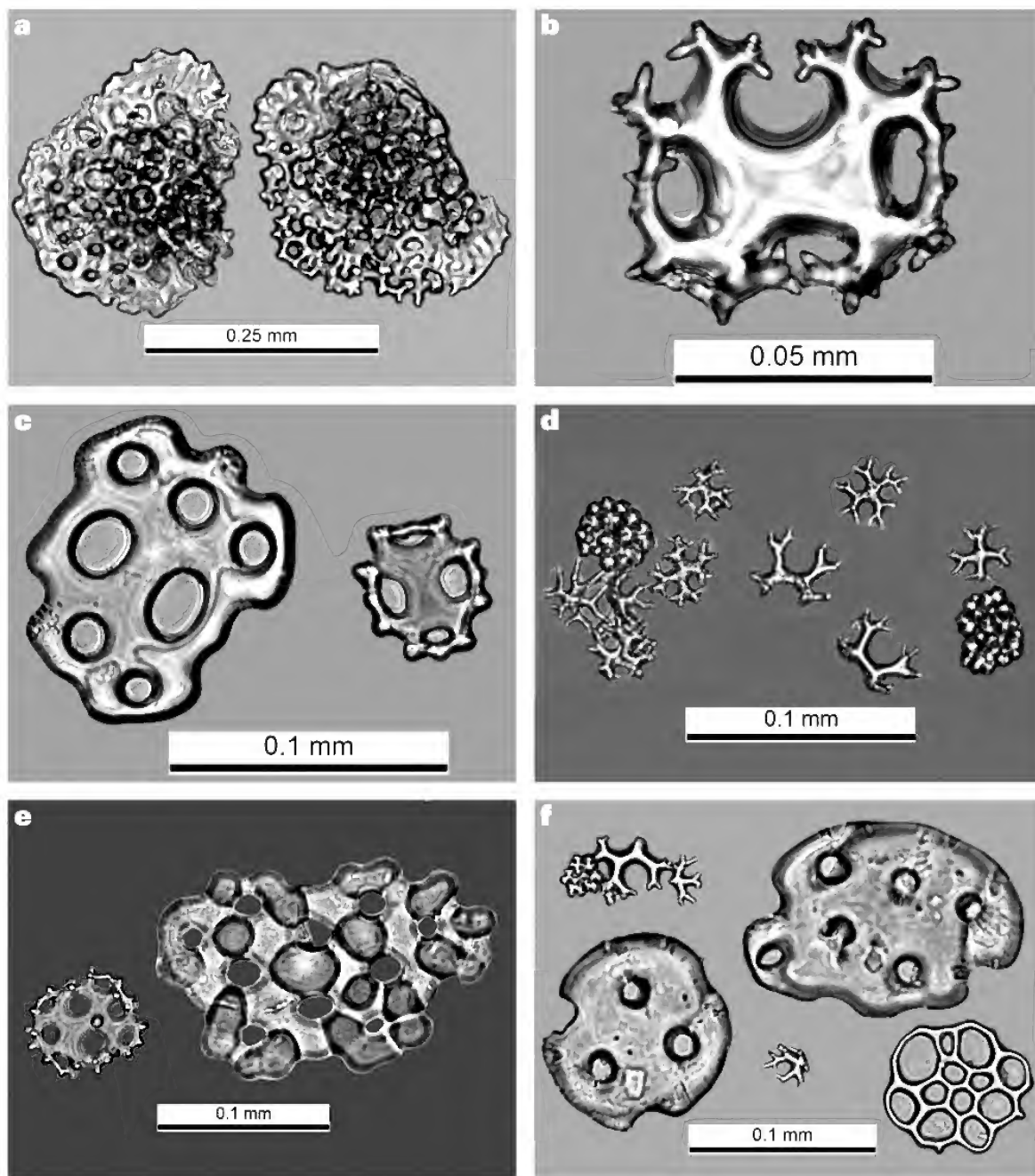


Figure 6. Photos of ossicles from Australian species of *Psolidium* Ludwig, 1886 (by Mark O'Loughlin and Chris Rowley): a, *P. granuliferum* H. L. Clark, 1938, multi-layered ossicles from the sole (SAM K2174); b–c, *P. laperosazi* sp. nov. (paratype SAM K2179); b, dorsal partly closed cup; c, cup and plate from sole; d–f, *P. marshae* sp. nov. (paratype WAM Z31165); d, dorsal small cupped crosses and rosettes; e, large cup and knobbed plate from sole; f, dorsal buttons, small endplate, large and small cupped crosses and rosette.

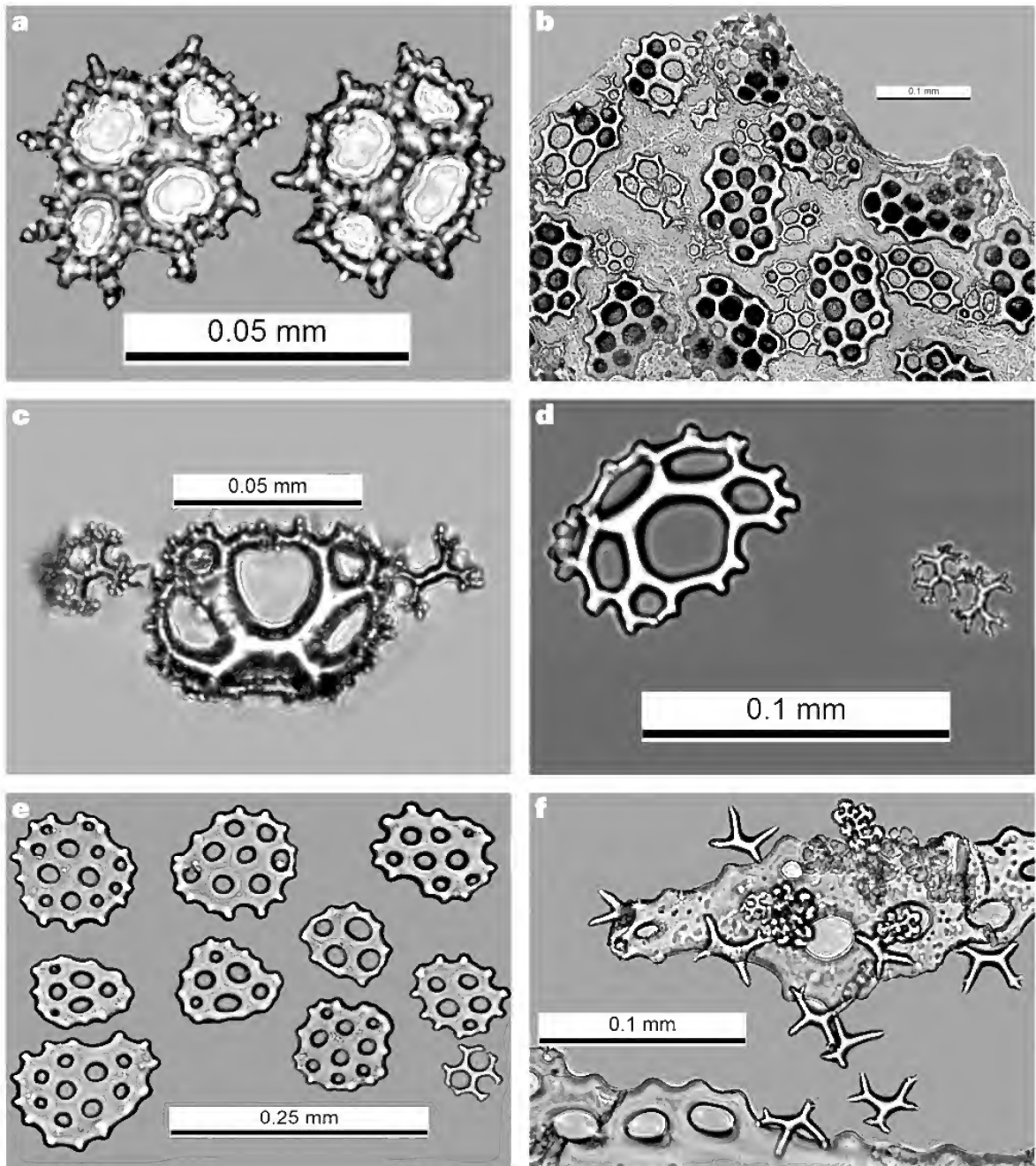


Figure 7. Photos of ossicles from Australian species of *Psolidium* Ludwig, 1886 (by Mark O'Loughlin and Chris Rowley): a–b, *P. mccallumae* sp. nov. (holotype NMV F126891); a, dorsal cups; b, mount of part of sole body wall, with plates and cups; c–d, *P. minutus* (H. L. Clark, 1938) (NMV F93176); c, dorsal large cup and small cupped crosses; d, large cup and small cupped crosses from sole; e–f, *P. nigrescens* H. L. Clark, 1938 (AM J6821); e, knobbed plates from sole; f, tentacle “thorns” and rosettes.

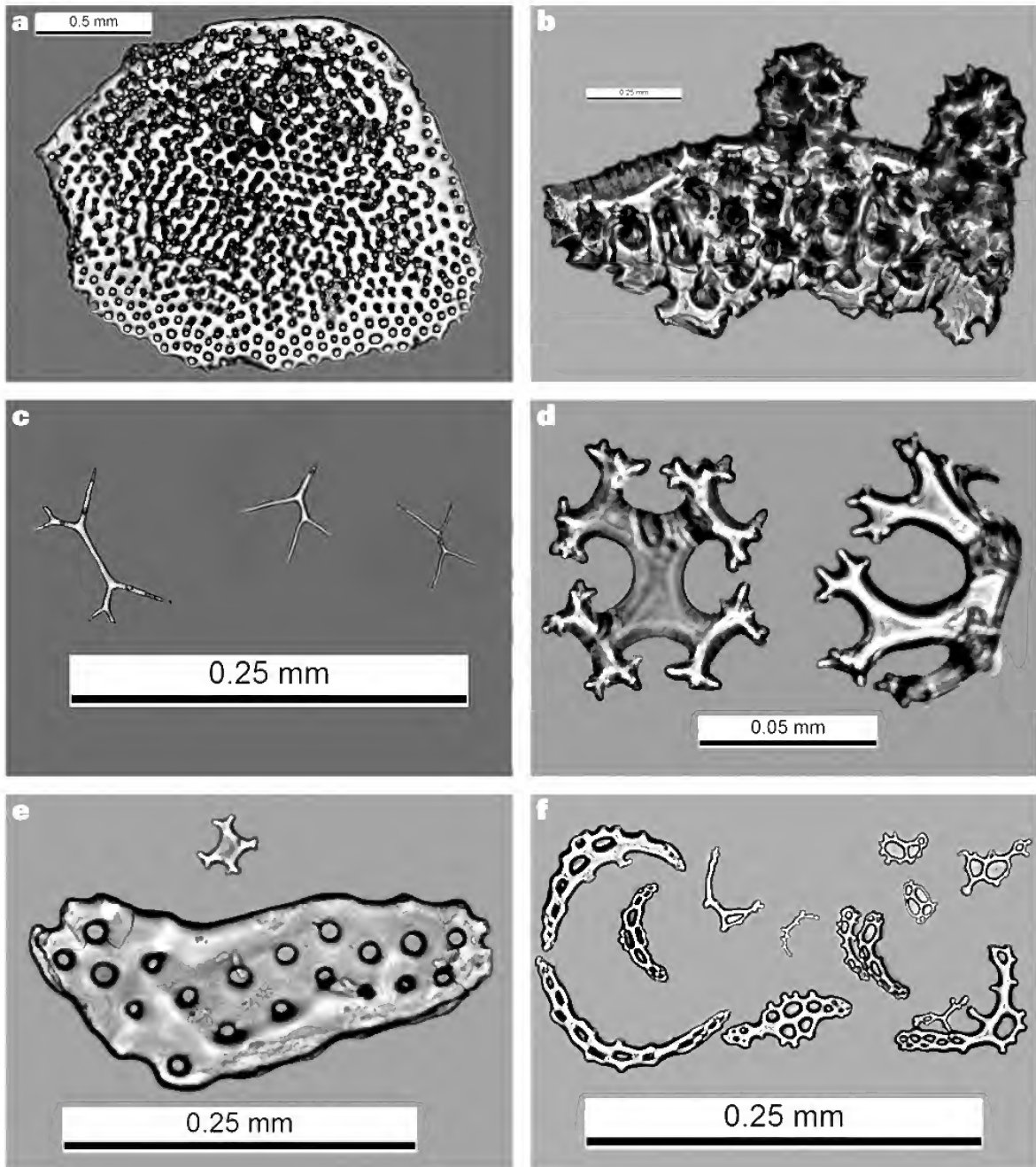


Figure 8. Photos of ossicles from Australian species of *Psolidium* Ludwig, 1886 (by Mark O'Loughlin and Chris Rowley): a–c, *P. parmatum* (Sluiter, 1901); a, dorsal scale with tube foot canal (holotype V.ECH.H1300); b, pillars on edge of part of scale (NMV F109378); c, dorsal “thorns” (holotype V.ECH.H1300); d–e, *P. ravum* Hickman, 1962 (SAM K2180); d, dorsal cupped crosses; e, cupped cross and plate from sole; f, *P. spinuliferus* (H. L. Clark, 1938), tentacle rods and dendritic branch endplates (top right) (AM J24096).

Psolidium berentsae sp. nov.

Table 1, Figures 2a, 5a–c

Material examined. Holotype: Queensland, Lizard I., off western side of Palfrey I., washings from coral blocks, 14°40'S 145°28'E, 6 m, P. B. Berents and P. A. Hutchings, 12 Jan 1976, stn 76 LIZ 16B, AM J24098.

Paratypes: type locality and date, J24099 (2); type locality and date, stn 76 LIZ 16A, J24100 (1).

Other material (up to 6 mm long; no cups detected): Chinamans Head, washings from coral blocks, 14°36'S 145°37'E, 6 m, P. A. Hutchings and P. B. Weate, 10 Jan 1976, stn 76 LIZ 15, J24101 (1); off Chinamans Head, reef rock, 14°40'S 145°28'E, 7 m, P. A. Hutchings and P. B. Weate, 27 May 1976, stn 76 LIZ B-00-03-3, J24102 (1); No Name Reef, southwest end, rubble from base of bommie, 14°40'S 145°39'E, 15 m, I. Loch, 19 Dec 1984, J24106 (1).

Other material (up to 11 mm long; no ossicles; presumably initial formalin preservation): Lizard I., off Chinamans Beach, coral block, 14°40'S 145°28'E, 7 m, P. A. Hutchings, Apr 1978, stn D15-27-1, J24104 (1); Outer Yonge Reef, 14°37'S 145°38'E, 18 m, P. A. Hutchings, 15 Jan 1977, stn 77 LIZ 47-4, J24105 (3).

Description. *Psolidium* species up to 12 mm long (preserved); body rounded in transverse section ventrally; dorsal and lateral scales thick, up to 1.3 mm wide; oral, anal and mid-body scales frequently tapering to projecting, bluntly pointed distal end, body surface very uneven.

Sole with peripheral band of tube feet, outer single series of slightly smaller tube feet, inner series 2 wide; mid-ventral radial series 2 wide; sole not discrete in very small specimens (4–6 mm long), small scales conspicuous.

Dorsal and lateral ossicles: multi-layered ossicles (scales), thick, with tube foot canals; buttons numerous, perforated, thick, irregularly oval, thickly knobbed, up to 176 μ m long, up to 12 perforations, intergrade with multi-layered ossicles; in larger specimens (12 mm long) cups numerous, deeply cupped, thick cruciform base, rim bluntly spinous, cups sometimes “bridged” with transverse branches from rim joined, cups 56–96 μ m long; in small specimens (4–6 mm long) numerous thin cupped crosses and cups, with elongate pointed spines on rim, cups up to 80 μ m long; rosettes numerous in larger specimens, densely branched, irregularly oval in form, up to 56 μ m long.

Sole ossicles: numerous knobbed plates, elongate, irregular in shape, large marginal and surface knobs, 3–12 perforations, up to 240 μ m long; rare smooth elongate, perforated plates, up to 240 μ m long.

Tentacle ossicles include abundant rosettes, densely branched, up to 40 μ m long.

Colour (preserved). Dorsal and lateral dark to pale brown, sometimes with brown flecking; sole off-white; tentacle trunks brown, dendritic branches off-white; introvert off-white.

Distribution. Queensland, Lizard I., 14°36'–14°40'S 145°28'–145°39'E, coral rocks and rubble; 6–18 m.

Etymology. Named for Dr Penny Berents (Scientific Officer, Marine Invertebrates, Australian Museum), with appreciation of her contribution to Australian marine invertebrate research, and with gratitude for her gracious assistance with loans and research in the Australian Museum.

Remarks. Some of the paratype specimens are small, 4 mm long (J24099 (2)). In this material the cups and cupped crosses are much finer than in the larger type material. This is judged to be a developmental difference. Some of the non-type specimens assigned to the new species are small, with specimen lengths 4 mm (J24101), 5 mm (J24102) and 6 mm (J24106). No cups or cupped crosses were detected, and this was judged to be a sampling inadequacy for this very small material, since fine cups and cupped crosses were found in 4 mm long paratype. The specimens have the same appearance as the types, and are from the type locality and eco-niche. Further collecting and study might reveal the presence of an additional species. Other additional material judged to be *P. berentsae* sp. nov. has the body form and scale outlines of the species, but lacks calcareous material. The preservation history presumably included time in acidic formalin solution. Specimen lengths are 5 mm (J24104) up to 11 mm (J24105). A rounded ventrum, absence of discrete sole and presence of conspicuous scales ventrally appear to be juvenile developmental characteristics. The distinguishing characters of *P. berentsae* sp. nov. are the tapered body scales, rounded ventrum, fine cups with long pointed spines in small specimens, and thick cups with blunt spines and sometimes “bridges” in large specimens.

Psolidium granuliferum H. L. Clark

Table 1, Figures 1a, 2b, 4c, 6a

Psolidium granuliferum H. L. Clark, 1938: 503–04, fig. 49.—H. L. Clark, 1946: 415.—Rowe, 1982: 458, 464, pl. 31.4.—Rowe (in Rowe and Gates), 1995: 318.

Material examined. Holotype: Western Australia, Koombana Bay, Bunbury, 9–15 m, C-A-H Expedition, 26 Oct 1929, MCZ 1666.

Other material. Cape Nauraliste, Geographe Bay, Map Reef, near Two Rocks, limestone reef, coralline foliose algae, 31°28.36'S 115°33.63'E, 7.6 m, A. Sampey, 18 Jul 2005, WAM Z31164 (1); South Australia, W Eyre Peninsula, Smokey Bay, 37 m, N. Pearsons, 1971, SAM K2176 (2); Tasmania, Port Davey, Bramble Cove, NW end, under rock, 4–6 m, K. L. Gowlett-Holmes, 17 Mar 2003, SAM K2174 (2); live colour photo SAM PK 0259).

Description. *Psolidium* species up to 21 mm long (preserved); body height low to moderately high, dorsal and lateral scales thick, up to 3 mm wide, lumps on surface creating coarsely granuliform appearance; abundant small scales at base of larger scales; tube feet dorsally and laterally inconspicuous, sparse across mid body, usually present near base of scales.

Sole: peripheral band of tube feet, outer single series of distinctly separate smaller tube feet; series of inner larger tube feet 2 wide, series not always continuous anteriorly and posteriorly; lacking series of mid-ventral radial tube feet.

Dorsal and lateral ossicles: multi-layered perforated ossicles (scales), thick, large surface lumps, canals for tube feet, intergrade with single-layered perforated plates; lacking cups, cupped crosses, rosettes.

Ventral ossicles: small to large single-layered perforated plates, up to 22 perforations, thin to moderately thick, irregularly round to oval, up to 312 μ m long, plate surfaces with abundant fine to medium knobs and rare large peripheral knobs, plate margins knobbed to bluntly spinous (fewer surface and peripheral knobs in plates from small specimens); large specimens have

perforated plates with secondary surface developments, intergrading into multi-layered ossicles.

Tentacles lack rosettes.

Colour. *Live.* Dorsally and laterally grey with off-white; white ventrally.

Preserved. Dorsally and laterally grey, or pale to darker brown with off-white; off-white ventrally.

Distribution. SW Western Australia (Koomana Bay) to SE Tasmania (Port Davey); 4–37 m.

Remarks. The distinguishing characteristics of *Psolidium granuliferum* H. L. Clark, 1938 are the absence of a mid-ventral radial series of tube feet on the sole, inconspicuous dorsal and lateral tube feet, coarsely granuliform dorsal and lateral scales, numerous small scales at the base of the large dorsal and lateral scales, and multi-layered ossicles in the sole of larger specimens. In the smallest specimens the sole has perforated plates with fewer knobs, and lacks perforated plates with secondary surface developments and multi-layered ossicles.

***Psolidium hutchingsae* sp. nov.**

Table 1, Figures 2c–d, 5d–f

Material examined. Holotype: N New South Wales, 50 m west of Split Solitary I, 30°14'S 153°10'48"E, *Herdmania momus*, rocks, sponges, ascidians, 15 m, P. A. Hutchings and L. C. Rose, 7 Mar 1992, stn NSW 677, AM J24107. Paratype: Type location and date, J24108 (1).

Other material. Coffs Harbour, SE Islet, 30°19'S 153°09'E, 12 m, A. Hoggett and D. Johnson, 22 Jan 1982, J15469 (1); Port Stephens, 32°37'S 152°04'E, surface of ascidian, S. Smith, 1985, J19665 (1).

Description. *Psolidium* species up to 18 mm long (preserved); dorsal and lateral body scales thick, up to 2.2 mm wide, body surface uneven; oral and anal scales tapering to narrow rounded end distally.

Sole with peripheral irregular band of tube feet, about 4–5 wide, lacking discrete outer series of smaller tube feet; mid-ventral radial series of tube feet, about 2 wide.

Dorsal and lateral ossicles: multi-layered ossicles (scales) thick, up to 4 tube foot canals; buttons perforated, irregularly oval, thick, smallest 80 μ m long with 3 perforations, intergrade with thickened and knobbed perforated plates and with multi-layered ossicles; crosses abundant, deeply cupped, arms bifurcate, arms distally finely spinous, cupped crosses 56–88 μ m long; rosettes rare, up to 32 μ m long.

Sole ossicles: knobbed to thickened perforated plates, marginal and surface knobs, variable shape from flat crosses to irregular plates with up to 12 perforations, up to 160 μ m long; shallow concave crosses rare, arms bifurcate, arms bluntly spinous to finely knobbed distally, up to 72 μ m long; shallow cups rare, knobs to short digitiform spinelets on rim, cups up to 96 μ m long.

Tentacle ossicles include irregular, thick, perforated, plates, up to 320 μ m long; abundant rosettes, densely branched, up to 80 μ m long.

Colour. *Preserved.* Dorsally and laterally pale to dark grey-brown, some specimens with dark brown patches or spotting; sole off-white; tentacle trunks brown, dendritic branches off-

white; introvert off-white.

Distribution. Northern New South Wales, Split Solitary I, Coffs Harbour and Port Stephens; rock, sponge, ascidians; 12–15 m.

Etymology. Named for Dr Pat Hutchings (Senior Principal Research Scientist, Australian Museum), with appreciation of her contribution to Australian marine invertebrate research and in particular for the collection and documentation of specimens described in this work.

Remarks. The distinguishing characteristics of *Psolidium hutchingsae* sp. nov. are the presence dorsally of abundant deeply cupped crosses with bifurcate arms that are distally finely spinous, and large rosettes and irregular plates in the tentacles.

***Psolidium karenae* sp. nov.**

Table 1, Figure 1b, 2e, 4d

Material examined. Holotype: South Australia, Spencer Gulf, Yorke Peninsula, Port Victoria jetty, under rock, 5–6 m, K. L. Gowlett-Holmes and W. Zeidler, 14 Dec 1994, SAM K2177 (live colour photo SAM PK 0105).

Paratypes: St Vincent Gulf, Kemps Ground, 12 m, N. Holmes, Apr/May 1985, K2188 (1); Adelaide, Hallett Cove, R. Balfour, 1970, K2184 (3); Moana Beach, reef off S end, 10 m, K. L. Gowlett-Holmes, 4 Apr 1987, K2185 (3); Nuyts Archipelago, just N of centre of W island, Franklin I, 6–8 m, P. Aelfeldt et al., 14 Apr 1983, SAM K2187 (1); St Francis I, W end of N beach, among rocks, 3 m, W. Zeidler, 24 Jan 1982, K2181 (2).

Description. *Psolidium* species up to 32 mm long (preserved); body height low to moderately high, dorsal and lateral body scales thick, finely granuliform, large, up to 4.5 mm wide, with sparse small scales at base; dorsal and lateral tube feet conspicuous, pass through centre of scales.

Sole: peripheral band of tube feet, outer single series of distinctly separate smaller tube feet, inner series of larger tube feet, 2–3 wide, series not always continuous anteriorly and posteriorly; mid-ventral radial series of tube feet, irregularly spaced, 1–2 wide.

Dorsal and lateral ossicles: multi-layered perforated ossicles (scales), thick, fine surface lumps, canals for tube feet, intergrade with single-layered perforated plates up to 160 μ m; lacking cupped crosses, cups, rosettes.

Ventral ossicles: small to large single-layered perforated plates, typically up to 24 perforations, up to 46 perforations in larger specimens, thin to moderately thick, irregularly round to oval, up to 240 μ m long, plate surfaces with abundant fine to medium knobs and rare large peripheral knobs, plate margins knobbed to bluntly spinous; perforated plates from small specimens with fewer surface and peripheral knobs; large specimens lack secondary surface developments on perforated plates, and multi-layered ossicles.

Tentacles lack rosettes.

Colour. *Live.* Dorsally dark reddish-brown.

Preserved. Dorsally pale to dark brown to grey-brown; sole off-white to cream to pale brown.

Distribution. South Australia, St Vincent Gulf to Nuyts Archipelago; 3–12 m.

Etymology. Named for Karen Gowlett-Holmes (CSIRO Marine and Atmospheric Research; Eaglehawk Dive Centre) in appreciation of her contribution to marine invertebrate research, and with gratitude for her fieldwork and photography that contributed substantively to this work.

Remarks. The distinguishing characteristics of *Psolidium karenae* sp. nov. are the conspicuous dorsal and lateral tube feet, finely granuliform dorsal and lateral scales, sparse small scales at the base of the large dorsal and lateral scales, absence of cups, cupped crosses and rosettes, and presence of separate single outer series of smaller peripheral tube feet around the sole. In the sole of the smallest specimens the perforated plates have fewer knobs.

***Psolidium laperousazi* sp. nov.**

Table 1, Figures 1c, 2f, 6b–c

Material examined. Holotype: SE Tasmania, D'Entrecasteaux Channel, Tinderbox, E of boat ramp, 1.5–3 m, K. L. Gowlett-Holmes, 14 Jul 1991, SAM K2172.

Paratypes: type locality and date, K2339 (2); South Australia, Kangaroo I, b/wn Western River Cove and Snug Cove, W side, 8–10 m, K. L. Gowlett-Holmes, 24 Feb 2003, K2179 (1, live colour photo SAM PK0253).

Description. *Psolidium* species up to 27 mm long (preserved); body height low to moderately high; dorsal and lateral scales thick, embedded in thick integument, imbricating, up to 1.5 mm wide; dorsal and lateral tube feet conspicuous, abundant.

Sole: peripheral band of tube feet, 3–4 wide, not always continuous anteriorly and posteriorly, lacking series of distinctly separate outer small tube feet; regular, close series of mid-ventral radial tube feet, 2 wide.

Dorsal and lateral ossicles: multi-layered perforated ossicles (scales), thick, irregular form; deeply cupped crosses and more abundant partially and fully closed cups, 40–72 μm , typical size range 56–64 μm long, cup rim densely, finely spinous; small to large buttons, up to 12 perforations, thick, smooth, irregular form, up to 264 μm long, intergrade with multi-layered ossicles.

Ventral ossicles: predominantly large single-layered perforated plates, up to 20 perforations, rarely up to 42 perforations in larger specimens, variable thickening, irregularly round to elongate, smooth, irregular margin, up to 368 μm long; perforated plates with variable surface and peripheral knobs rare; perforated plates with 4 perforations rare; moderately deep to deeply cupped crosses and more abundant partially and fully closed cups, 48–64 μm long, typical size range 48–56 μm long, cup rim bluntly spinous.

Tentacle ossicles include rosettes, irregularly oval, densely branched, up to 80 μm long in larger specimens.

Colour. Live: dark pink dorsally. Preserved: pale brown to cream dorsally and ventrally; small, discrete, dark brown spots may be present on the sole.

Distribution. SE Tasmania (D'Entrecasteaux Channel) to South Australia (Kangaroo I); 1–10 m.

Etymology. Named for Thierry Laperousaz (Collection Manager,

Marine Invertebrates, South Australian Museum), with gratitude for his prompt and gracious assistance with loans.

Remarks. The distinguishing characteristics of *Psolidium laperousazi* sp. nov. are the embedding of the dorsal and lateral scales in thick integument, the abundant and conspicuous tube feet, the predominance of cups over cupped crosses dorsally and ventrally, large rosettes in the tentacles, and the presence of dark spots on the sole.

***Psolidium marshae* sp. nov.**

Table 1, Figures 1d, 3a, 6d–f

Material examined. Holotype: Western Australia, Cape Naturaliste, Geographe Bay, Bunker Bay, granite reef, brown algae canopy, *Cystophora*, 33°32.152'S 115°01.993'E, 5.4 m, A. Sampey, 15 Apr 2005, WAM Z31173.

Paratype: Eagle Bay, granite reef, brown algae canopy, *Sargassum*, *Cystophora*, 33°33.387'S 115°04.078'E, 4.9 m, A. Sampey, 2 Feb 2005, Z31165 (1).

Other material. South Australia, Kangaroo I, b/wn Western River Cove and Snug Cove, 12–14 m, under rock, on coralline red alga or sponge, K. L. Gowlett-Holmes, 14 Mar 2004, SAM K2173 (1, live colour photo SAM PK0273).

Description. *Psolidium* species up to 10 mm long (preserved); very uneven surface; dorsal and lateral scales thick, up to 1.5 mm wide; oral and anal scales small, tapering to rounded end distally.

Sole with peripheral band of tube feet, band up to 4 wide, size variable, outermost series slightly smaller; mid-ventral radial series irregular, up to 4 wide; peripheral series of tube feet variably continuous anteriorly and posteriorly.

Dorsal and lateral ossicles: multi-layered ossicles (scales) thick, tube foot canals; buttons numerous, thick, smooth, not knobbed, irregularly oval, 3–9 perforations, up to 216 μm long; crosses small, deeply cupped, most quadri-radiate, some tri- or penta-radiate, abundant, typically 32 μm long, arms distally spinous, spinelets long, spinelets sometimes joined to close rim to form cups; rosettes abundant, oval, typically 32 μm long.

Sole ossicles: knobbed plates numerous, variable form, 4–16 perforations, thickly knobbed on surface and marginally, up to 240 μm long; cups and cupped crosses shallow concave, with digitiform spinelets marginally only; cups and cupped crosses of 2 sizes, larger typically 72 μm long, of variable form, some intergrading with knobbed plates, smaller typically 32 μm long, quadri-radiate or tri-radiate base, marginal rim closed or not.

Tentacle ossicles include abundant rosettes, oval, up to 56 μm long.

Colour. Live. Predominantly white with some brown patches.

Preserved: dorsally and laterally off-white with dark brown-black patches and flecks; sole off-white; tentacle trunks with dark brown markings.

Distribution. Western Australia, Cape Naturaliste, Geographe Bay; granite; 5 m; South Australia, Kangaroo I; 12–14 m.

Etymology. Named for Loiset Marsh (Research Associate, Marine Invertebrates Section, Department of Aquatic Zoology,

Western Australian Museum), in appreciation of her considerable contribution to echinoderm systematic and biogeographical research, and with gratitude for her gracious assistance with loans of echinoderm specimens for systematic research.

Remarks. The distinctive characters of *Psolidium marshae* sp. nov. are the presence of 2 size ranges of cupped crosses and cups in the sole, and presence of rosettes in the body wall.

***Psolidium mccallumae* sp. nov.**

Table 1, Figures 3b, 7a–b

Material examined. Holotype: Western Australia, off Point Cloates, upper continental slope, hard substrate, *Southern Surveyor* SS10/2005 stn 139, 22.85°S 113.51°E, 100 m, 9 Dec 2005, NMV F126891.

Description. *Psolidium* species up to 7 mm long (preserved); dorsal and lateral body scales thick, up to 1.3 mm wide, oral and anal cone scales tapering to projecting angled spine; dorsal and lateral tube feet conspicuous.

Sole with peripheral band of tube feet, outer single series of slightly smaller tube feet, inner single series; lacking mid-ventral radial series of tube feet.

Dorsal and lateral ossicles: multi-layered ossicles (scales), up to 2 tube foot canals; cups shallow, 4–8 perforations, cross and rim covered with fine spinelets, cups 40–72 μ m long; rosettes rare, small, up to 32 μ m long.

Sole ossicles: smooth, irregular perforated plates, up to 16 perforations, up to 184 μ m long; shallow cups with finely spinous rim, typically 4 perforations, typically 48 μ m long; lacking rosettes.

Colour (preserved). White dorsally, laterally, ventrally.

Distribution. Central Western Australia, off Point Cloates, upper continental slope, hard substrate; 100 m.

Etymology. Named for Anna McCallum (Marine Biology Section, Museum Victoria) with appreciation of her participation in the collection of this material on the *Southern Surveyor*, and her careful curation of this holothuroid collection in Museum Victoria.

Remarks. The distinctive character of *Psolidium mccallumae* sp. nov. is the complete cover of small spinelets on the cross and rim of the shallow dorsal cups.

***Psolidium minutus* (H. L. Clark)**

Table 1, Figures 7c–d

Psolus minutus H. L. Clark, 1938: 507–09, figs 51–52. — H. L. Clark, 1946: 414. — Pawson, 1968b: 21 (key). — Cannon and Silver, 1987: 29.

Psolidium minutus. — Rowe (in Rowe and Gates), 1995: 318. — Coleman, 2002: 65, fig.

Material examined. Paratypes: Lord Howe I, Neds Beach, under rock, Apr 1932, AM J6450 (3).

Other material. Neds Beach, under rock, N. Coleman, 20 Jul 2002, NMV F93176 (1); Middleton Reef, shallow reef front, 29°27.2'S 159°06.8'E, sandy bottom, 10 m, 4 Dec 1987, AM J20901 (1).

Description. *Psolidium* species up to 10 mm long (live); dorsal and lateral body scales thick to thin, bluntly toothed on free

edge, up to 1.3 mm wide; tube feet pass through scales.

Sole with peripheral band of tube feet, outer single series of smaller tube feet, inner single series; mid-ventral radial series of tube feet 2 wide.

Dorsal and lateral ossicles: single to multi-layered ossicles (scales) with tube foot canals; large cups shallow to deep, closely finely spinous rim, large cups 48–80 μ m long; small cupped crosses and cups deep, closely finely spinous distal arm branches and cup rim, small crosses and cups up to 24 μ m long; lacking rosettes.

Sole ossicles: perforated plates, irregularly round to elongate, smooth, marginally slightly knobbed to bluntly spinous, up to 36 perforations, up to 360 μ m long; shallow cups with finely spinous rim, typically 4 perforations, typically 48 μ m long; very small deeply cupped crosses and cups, finely closely spinous on distal arm branches and rim, up to 20 μ m long; lacking rosettes.

Tentacles lack rosettes.

Colour. Live colour white, tentacles yellowish (H. L. Clark, 1938; Coleman, 2002: 65, fig.).

Distribution. Tasman Sea, Lord Howe I, Middleton Reef; 1–10 m.

Remarks. The distinctive characters of *Psolidium minutus* (H. L. Clark, 1938) are the presence of 2 size ranges of cupped crosses and cups in the sole, and absence of rosettes in the body wall. H. L. Clark (1938) noted that Dr Deichmann had called his attention to the fact that the ossicles in *Psolus minutus* resembled those in some species of *Psolidium*. Rowe (1995) reassigned *Psolus minutus* to *Psolidium* on the basis of dorsal tube feet penetrating the scales.

***Psolidium nigrescens* H. L. Clark**

Table 1, Figures 3c–d, 7e–f

Psolidium nigrescens H. L. Clark, 1938: 505–507, fig. 50. — H. L. Clark, 1946: 414–15. — Cannon and Silver, 1987: 29. — Rowe (in Rowe and Gates), 1995: 318.

Material examined. New South Wales, Broken Bay, Hawkesbury River, Yeomans Bay, Smith-MacIntyre Grab, mud sediment, G. Phillipson, Oct 1992 (specimen not lodged in museum); Port Jackson, Middle Harbour, N bank W of Spit Bridge, 33°48'S 151°15'E, steeply sloping bottom with telestacean bed, live and dead mussels, *Tethia* sp. and compound ascidians, 8 m, J. K. Lowry, 9 Jun 1981, J24097 (1); Botany Bay, off Dolls Point, dredged, 7–11 m, D. F. McMichael, Oct 1949, J6789 (4); Port Hacking, Gunnamatta Bay, 34°04'30"S 151°08'54"E, on shells of *Anadara*, I. Bennett, 2 Nov 1948, AM J6821 (6); Batemans Bay, Clyde R, edge of channel near southern bank downstream from Princes Hwy road bridge, 35°42'34"S 150°11'3"E, 5 m, clump of hairy mussels, Australian Museum party, 30 Mar 2004, J24092 (3).

Description. *Psolidium* species up to 40 mm long (preserved); body elongate; dorsal and lateral body scales thick, up to 4 mm wide, covered by fairly thick integument; scales tapered to projecting rounded point orally and anally; dorsal and lateral tube feet conspicuous, up to 5 pass through a scale.

Sole with peripheral band of tube feet, about 5 wide, outermost tube feet not smaller; mid-ventral radial series of tube feet predominantly 2 wide.

Dorsal and lateral ossicles: multi-layered ossicles (scales) with tube foot canals; thick knobbed buttons, 3–10 perforations,

up to 192 μm long, intergrade with multi-layered ossicles; branched rods with pointed ends ("thorn" ossicles), irregular form, 3–5 arms, flat to 3-dimensional, up to 56 μm long; rosettes, densely branched, up to 40 μm long.

Sole ossicles: perforated plates, slightly concave, irregularly round, knobbed marginally, up to 14 perforations, up to 152 μm long; very shallow, marginally knobbed, 4-perforation cups and cupped crosses, typically 96 μm long; rare rosettes; rare "thorn" ossicles.

Tentacle ossicles include: rosettes, up to 40 μm long; "thorn" ossicles, up to 40 μm long.

Colour (preserved). Dorsal and lateral body black to brown to dark grey, with fine white spotting over scales; tube feet off-white; sole pale brown to cream, with some fine brown flecking; tentacle trunks dark brown, tentacle dendritic ends off-white.

Distribution. Eastern Australia, central New South Wales, Broken Bay to Batemans Bay, estuarine; 0–11 m.

Remarks. The distinguishing characters of *Psolidium nigrescens* H. L. Clark, 1938 are the "thorn" ossicles in the body wall, and very dark brown to black colour.

Psolidium parmatum (Sluiter)

Table 1, Figures 3e–f, 8a–c

Psolus parmatum Sluiter, 1901: 102–03, pl. 6 fig. 14.

Material examined. Holotype (very poor condition): Indonesia, Banda Sea, *Siboga* stn 259, 5°29.2'S 132°52.5'E, coral sand, 487 m, V.ECH. H1300.

Other material. Western Australia, Ningaloo North, *Southern Surveyor* SS2005/10 stn 163, 21.94°S 113.84°E, hard substrate, 133 m, 12 Dec 2005, NMV F112156 (1); Adele, SS05/2007 stn 161, 14.5622°S 122.9182°E, hard rubble, 95 m, 4 Jul 2007, F151835 (1); Kulumburu, SS05/2007 stn 176, 13.2247°S 123.3957°E, 400 m, F151836 (1).

Arafura Sea, *Southern Surveyor* SS05/2005 stn 42, 9°7.018'S 133°24.725'E, 204 m, 18 May 2005, F109377 (1); SS05/2005 stn 43, 9°5.312'S 133°2.989'E, 226 m, 19 May 2005, F109378 (1).

Description. *Psolidium* species up to 13 mm long (preserved); dorsal and lateral scales up to 2.0 mm wide, scales each with numerous blunt calcareous vertical projections; dorsal and lateral tube feet not conspicuous amongst projections.

Sole with peripheral band of tube feet, single outer series of smaller tube feet, inner single series of larger ones; lacking mid-ventral radial series of tube feet.

Dorsal and lateral ossicles: single to multi-layered perforated plates (scales), lace-like secondary surface developments to multi-layering, tube foot canals; each scale with numerous thick, bulbous calcareous spires, constricted basally, rounded distally, about 200 μm high, 136 μm widest diameter, finely spinous surface; irregular branched pointed rod "thorn" ossicles, up to 160 μm long; shallow concave cups, perforations large, typically 4 around central cross, frequently 4 smaller corner perforations, cups knobbed around margin and on cross, cups typically 120 μm long; lacking rosettes.

Sole ossicles: shallow concave cups, perforations large, typically 4 around central cross, frequently 4 smaller corner perforations, cups knobbed around margin and on cross, cups

typically 112 μm long; "thorn" ossicles up to 96 μm long; lacking rosettes.

Colour (preserved). White dorsally, laterally, ventrally.

Distribution. Indonesia (Banda Sea), Arafura Sea, to NW Western Australia (Ningaloo North); 95–487 m.

Remarks. Tube feet pass through the dorsal and lateral scales of *Psolus parmatum* Sluiter, 1901. The species is re-assigned here to *Psolidium* Ludwig. The distinctive species characteristic of *Psolidium parmatum* (Sluiter) is the presence of numerous blunt vertical calcareous projections on each of the dorsal and lateral scales. These projections resemble "shields" in profile, and hence the species name chosen by Sluiter (*parma*, Latin for "small shield").

Psolidium ravum Hickman

Table 1, Figures 1e, 8d–e

Psolidium ravum Hickman, 1962: 60–61, figs 75–86, pl. 2 fig. 7.—Dartnall, 1980: 51, 77.—Rowe, 1982: 458, 464, fig. 10.29c.—Rowe (in Rowe and Gates), 1995: 318–19.

Material examined. Syntype: SE Tasmania, Derwent Estuary, Ralphs Bay, dredged, 13 m, 28 Aug 1959, AM J7202 (1).

Other material: N point of Trial Bay, near Kettering, 3 m, under rock, 31 Mar 1991, SAM K2180 (1); Hobart, AM G248 (3); Frederick Henry Bay, Primrose Sands, Renard Point, under rock, 3–4 m, K. L. Gowlett Holmes, 25 Aug 1999, K2178 (1); Bass Strait, Lulworth, Black Rock Point, M. O'Loughlin et al., 22 Nov 1982, NMV F97439 (1); Tamar R., Greens Beach, M. O'Loughlin, 7 Mar 1981, NMV F97440 (1). Victoria, Bass Strait, Ninety Mile Beach, 10 km W of Seaspray, J. Watson, 1977, AM J11171 (1); Portland, 500 m E of Whalers Point Lighthouse, 10 m, under rocks, P. Berents and R. Springthorpe, 10 May 1988, AM J21980 (1); Saxon Reef, 10 m, J. Watson, 24 Feb 2007, NMV F125379 (1). South Australia, Spencer Gulf, Yorke Peninsula, Port Elizabeth, 7 m, K. Sheard, 23 Feb 1941, SAM K2182 (1); Pt Turton jetty, 3–4 m, N. Holmes, 31 Aug 1986, SAM K2186 (1); W Eyre Peninsula, Streaky Bay, Pt Westall, littoral, M. O'Loughlin, 15 Jan 1991, NMV F97438 (1); Nuyts Archipelago, Franklin I., 12–15 m, W. Zeidler and P. Aerfeldt, 23 Feb 1983, SAM K2183 (1).

Description. *Psolidium* species up to 40 mm long (preserved); body form oval to elongate; body height low to moderately high; dorsal and lateral scales thick, up to 2 mm wide, covered with thick integument; dorsal and lateral tube feet conspicuous, numerous.

Sole: peripheral band of tube feet, 4–5 wide, not always continuous anteriorly and posteriorly, lacking series of distinctly separate outer small tube feet; regular, close series of mid-ventral radial tube feet, 2 wide.

Dorsal and lateral ossicles: multi-layered perforated ossicles (scales), thick, irregular form; deeply cupped crosses with distal spinous to digitiform spinelets, rare partially or fully closed cups, 32–72 μm long, typical size range 40–56 μm long; small to large buttons, up to 12 perforations, thick, smooth, irregular form, up to 216 μm long, intergrade with multi-layered ossicles.

Ventral ossicles: predominantly large single-layered perforated plates, up to 16 perforations, rarely up to 38 perforations in larger specimens, variable thickening, irregularly round to elongate, smooth, irregular margin, up to 360 μm long;

perforated plates with variable surface and peripheral knobs rare; perforated plates with 4 perforations rare; moderately deep to deeply cupped crosses with distal spinous to knobbed spinelets, rare partially or fully closed cups, typical size range 40–48 μm long, rarely up to 56 μm long.

Tentacle ossicles include rosettes, irregularly oval, densely branched, up to 96 μm long in larger specimens.

Colour. Live: grey dorsally and laterally. Preserved: dark brownish-grey to off-white dorsally and laterally; sole brown to grey-brown.

Distribution. SE Tasmania (Derwent Estuary), Bass Strait, to W South Australia (Nuyts Archipelago); 0–15 m.

Remarks. Although not reported by Hickman (1962), the syntype and all of the specimens determined here to be *P. ravum* have rosettes in the tentacles. The specimen from the Eyre Peninsula (NMV F97438) ventrally has more abundant plates with 4 perforations, but the external morphology and presence of cupped crosses dorsally and ventrally are typical of *P. ravum*. The specimens from Frederick Henry Bay (SAM K2178) and Kettering (K2180) have similar morphological appearances to *P. laperosazi* sp. nov., but the dorsal and ventral ossicles are typical of *P. ravum*. Knobbed to spinous plate margins in the sole of the specimens from Port Elizabeth (SAM K2182) and Portland (NMV F125379) are similar to those of *P. karenæ* sp. nov. and *P. granuliferum* H. L. Clark, but the external morphology and presence of dorsal and ventral cupped crosses and cups are typical of *P. ravum*. Small ossicles were absent from specimens from Nuyts Archipelago (SAM K2183) and Yorke Peninsula (K2186) (probably formalin preservation history), but the specimens have the typical external morphology of *P. ravum*. The distinguishing characteristics of *Psolidium ravum* Hickman, 1962 are the conspicuous dorsal and lateral tube feet, the predominance of cupped crosses over cups dorsally and ventrally, large rosettes in the tentacles, and absence of dark spots on the sole.

Psolidium spinuliferus (H. L. Clark)

Table 1, Figures 4a, 8f, 9a–d

Psolus spinuliferus H. L. Clark, 1938: 509–11, fig. 53.—H. L. Clark, 1946: 414.—Cannon and Silver, 1987: 29.—Rowe (in Rowe and Gates), 1995: 319.

Material examined. Northern Territory, Darwin Harbour, North Shell I, 12°29'48"S 130°53'12"E, coral rubble covered with sponges and some algae, 5 m, P. A. Hutchings, 16 Jul 1993, stn NT 346, AM J24096 (1). Western Australia, Perth, Cottesloe, Mudurup Rocks, c70 m S of groynes, reef flat, *Sargassum* zone, on reef flat under thin veneer of sand, 31°59'51"S 115°45'01"E, 0–1 m, J. Keesing, 6 Feb 2007, WAM Z37479 (1); Trigg I, c100 m N of 'island', inshore mixed algal zone mid-platform with thin veneer of sand overlaying reef, 31°52'29"S 115°45'04"E, 0–1 m, J. Keesing, 19 Feb 2007, Z37478 (1); Waterman, *Sargassum* zone, mid-platform, 31°51'15"S 115°45'05"E, 0–1 m, J. Keesing, 14 Feb 2007, Z37468 (5); from mixed localities, Cottesloe and Trigg I, inter-tidal platforms, on reef flat under thin veneer of sand, J. Keesing, Feb 2007, Z37469 (1).

Description. *Psolidium* species up to 20 mm long (preserved); dorsal and lateral body scales thin, single-layered, with spires,

scales up to 1.5 mm wide; tube feet dorsally and laterally pass through scales, not conspicuous amongst spires.

Sole: peripheral band of tube feet, outer single series of smaller tube feet, inner single to zig-zag series; mid-ventral radial series irregular, double to zig-zag to scattered.

Dorsal and lateral ossicles: single-layered, thick, perforated plates (scales), irregularly oval, some with secondary thickening, most with vertical digitiform spire near margin; spires up to 400 μm long, 120 μm diameter, distally spinous.

Sole ossicles: knobbed plates, numerous, predominantly regular 4-holed thin plates, smooth to finely knobbed marginally, typically 80 μm long; lacking cupped crosses, cups, rosettes.

Tentacle ossicles include: thick perforated plates, elongate, variable form, some with secondary layer development, up to 352 μm long; numerous rosettes, large to small, frequently with 4 central perforations, densely branched, oval to elongate and distally rounded, up to 160 μm long, intergrade with elongate plates.

Colour(live and preserved). White, dorsally and ventrally.

Distribution. Northern Territory (Darwin), to Western Australia (Perth); 0–22 m.

Remarks. The dorsal and lateral tube feet are not conspicuous, and were not noticed by H. L. Clark (1938). *Psolus spinuliferus* H. L. Clark, 1938 is reassigned here to *Psolidium* Ludwig. The distinguishing characters of *Psolidium spinuliferus* (H. L. Clark) are the predominantly single-layered scales with vertical digitiform marginal spire. The type specimen (MCZ no. 1669) was taken off the Eighty Mile Beach near Broome in northwestern Australia, at 18–22 m.

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References

- Agassiz, L. 1845. *Nomina systematica generum echinodermatum tam viventium quam fossilium, secundum ordinem alphabeticum disposita, adjectis auctoribus, libris in quibus reperiuntur, anno editionis, etymologia et familiis, ad quas pertinent.* Jent et Gassmann: Soloduri: Switzerland.

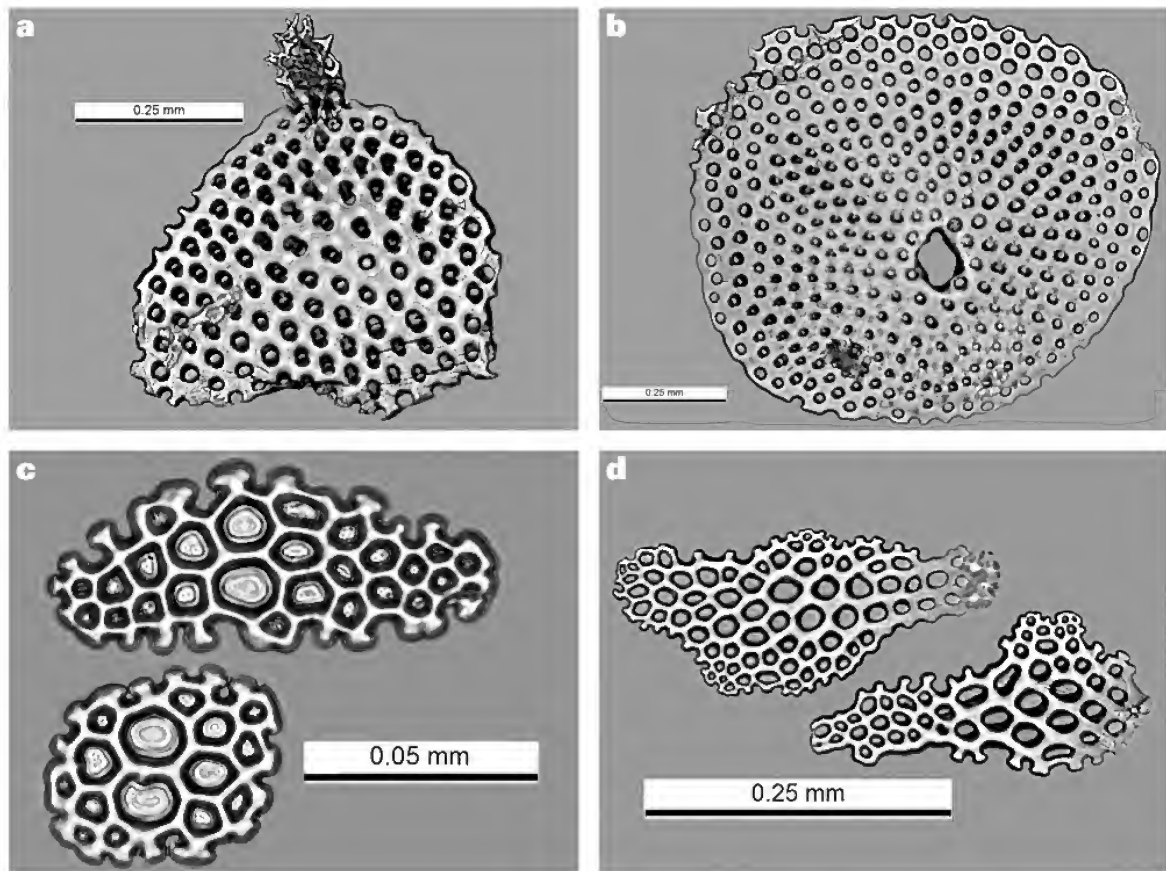


Figure 9. Photos of ossicles from Australian species of *Psolidium* Ludwig, 1886 (by Mark O'Loughlin and Chris Rowley): a–d, *P. spinuliferus* (H. L. Clark, 1938) (WAM Z37468); a, part of dorsal scale with marginal vertical spire; b, dorsal scale with tube foot canal and base of lost spire; c, tentacle rosettes; d, tentacle plates.

- Agassiz, L. 1848. *Nomenclatoris zoologici index universalis, continens nomina systematica classium, ordinum, familiarum et generum animalium omnium, tam viventium quam fossilium, secundum ordinem alphabeticum unicum disposita, adjectis homonymiis plantarum*. Jent et Gassmann: Soloduri: Switzerland.
- Baranova, Z.I., and Belyaev, G.M. 1968. Echinodermata. In: Zenkevich, L. A. (ed.), *La vie des animaux*. Izdatel'stvo Prosvetshchenic. Moscow 2: 197–297. (in Russian)
- Bell, J.F. 1882. Studies in the Holothuroidea. I. On the genus *Psolus* and the forms allied thereto. *Proceedings of the Zoological Society, London*. 1882: 641–50, pl. 158.
- Bronn, H.G. 1860. *Die klassen und ordnungen des thier-reichs, wissenschaftlich dargestellt in wort und bild*. 2. *Aktinozöen*. C. F. Winter'sche Verlagshandlung: Leipzig and Heidelberg. 434 pp., 49 pls.
- Cannon, L.R.G., and Silver, H. 1987. *Sea Cucumbers of Northern Australia*. Queensland Museum: Brisbane, Australia. i–viii, 60 pp.
- Carriol, R-P., and Féral, J-P. 1985. Réexamen de quelques Psolidae (Holothurioidea, Echinodermata) antarctiques et subantarctiques. Description de deux nouvelles espèces du genre *Psolus*. *Bulletin du Muséum national d'Histoire naturelle, Paris* 4(7) A(1): 49–60.
- Cherbonnier, G. 1974. Invertébrés marins des XIIème et XVème expéditions antarctiques Françaises en Terre Adélie. 15. Holothurides. *Tethys* 5(4): 601–10.
- Clark, H.L. 1901. Holothurians of the Pacific Coast of North America. *Zoologischer Anzeiger* 24: 162–71.
- Clark, H.L. 1938. Echinoderms from Australia. An account of collections made in 1929 and 1932. *Memoirs of the Museum of Comparative Zoology at Harvard College* 55: 1–596, 28 pls, 63 figs.
- Clark, H.L. 1946. The echinoderm fauna of Australia. Its composition and its origin. *Carnegie Institution of Washington Publication* 566: 1–567.
- Coleman, N. 2002. *Lord Howe Island Marine Park*. Neville Coleman's Underwater Geographic. 95 pp.

- Dartnall, A. 1980. *Fauna of Tasmania Handbook 3. Tasmanian echinoderms*. University of Tasmania: Hobart. 82 pp., 36 figs, 5 pls, 18 maps.
- Deichmann, E. 1940. Report on the Holothurians, collected by the Harvard-Havana expeditions 1938 and 1939, with a revision of the Molpadioida of the Atlantic Ocean. *Memorias Sociedad Cubana Historia Natural, Felipe Poey* 14(3): 183–240, 10 pls.
- Deichmann, E. 1941. The Holothuroidea collected by the *Velero III* during the years 1932–1938. I. Dendrochirotida. *Allan Hancock Pacific Expeditions* 8(3): 61–194, pls 10–30.
- Deichmann, E. 1947. Shallow water holothurians from Carbo de Hornos and adjacent waters. *Anales del Museo Argentino de Ciencias Naturales. Invertebrados Marinos* 8: 325–51.
- Deichmann, E. 1954. The holothurians of the Gulf of Mexico. *Fishery Bulletin of the Fish and Wildlife Service* 89(55): 381–410.
- Dendy, A. 1896. Observations on the Holothurians of New Zealand; with descriptions of four new species, and an appendix on the development of the wheels in *Chirodota*. *Journal of the Linnean Society of London, Zoology* 26: 22–52.
- Forbes, E. 1841. *A history of British starfishes and other animals of the class Echinodermata*. John van Voorst: London. 267 pp.
- Gistel, T. 1848. Echinodermata. Class 11. Pp. 174–77 in: *Naturgeschichte des Thierreichs für höhere Schulen*. Stuttgart. xvi+216 pp., 32 pls.
- Grube, A.E. 1840. *Aktinien, Echinodermen und Würmer des Adriatischen und Mittelmeeres*. J. H. Bon: Königsberg. 92 pp.
- Gutt, J. 1988. Zur Verbreitung und Ökologie der Seegurken (Holothuroidea, Echinodermata) im Weddellmeer (Antarktis). *Berichte zur Polarforschung* 41: 1–87.
- Gutt, J. 1990. New Antarctic holothurians (Echinodermata) —I. Five new species with four new genera of the order Dendrochirotida. *Zoologica Scripta* 19(1): 101–17.
- Haeckel, E., 1896. Systematische Phylogenie der Echinodermen. Pp. 348–504 in: *Systematische Phylogenie der Wirbellosen Thiere (Invertebrata)*. Zweiter Teil des Entwurfs einer systematischen Stammesgeschichte. Reimer: Berlin. 720 pp.
- Hickman, V.V. 1962. Tasmanian sea-cucumbers (Holothuroidea). *Papers and Proceedings of the Royal Society of Tasmania* 96: 49–72, 2 pls, 186 figs.
- Jäger, G.F. 1833. *De Holothuriis. Dissertatio Inauguralis*. Turici. 40 pp., 3 pls.
- Joshua, E.C. 1914. Victorian Holothuroidea, with descriptions of new species. *Proceedings of the Royal Society of Victoria. New Series* 27(1): 1–11.
- Lambert, P. 1996. *Psolidium bidiscum*, a new shallow-water psolid sea cucumber (Echinodermata: Holothuroidea) from the northeastern Pacific, previously misidentified as *Psolidium bullatum* Ohshima. *Canadian Journal of Zoology* 74: 20–31.
- Ludwig, H. 1886. Die von G. Chierchia auf der Fahrt der Kgl. Italienische Corvette *Vettor Pisani* gesammelten Holothurien. *Zoologische Jahrbücher* 2: 1–36, 2 pls.
- Ludwig, H. 1892. Echinodermen. Pp. 32–61, pls 15–17 in: Bronn, H. G., *Klassen und Ordnungen des Thier-Reichs* 2(3) 3 Das System. C. F. Winter'sche Verlagshandlung: Leipzig and Heidelberg. 460 pp., 17 pls.
- Ludwig, H., and Heding, S. G. 1935. Die holothurien der Deutschen Tiefsee-Expedition. I. Fusslose und dendrochirote formen. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem dampfer Valdivia 1898–1899* 24: 123–214.
- Massin, C. 1992a. Holothurians (Echinodermata) from Marion and Prince Edward Islands: new and little-known species. *Zoologica Scripta* 21(3): 311–24.
- Massin, C. 1992b. Three new species of Dendrochirotida (Holothuroidea, Echinodermata) from the Weddell Sea (Antarctica). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie* 62: 179–91.
- Massin, C. 1997. First record of a Psolidae (Holothuroidea, Echinodermata) in the Mediterranean Sea (Sicilian Channel). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie* 67: 101–06.
- Mitsukuri, K. 1912. Studies on Actinopodous Holothuroidea. *Journal of the College of Science, Tokyo Imperial University* 29(2): 284 pp., 8 pls.
- Mortensen, T. 1925. Echinoderms of New Zealand and the Auckland-Campbell Islands. 4. Holothuroidea. Pp. 322–86 in: *Papers from Dr. Th. Mortensen's Pacific Expedition 1914–1916*. 29. Videnskabelige Meddelelser Dansk Naturhistorisk Forening, København 79.
- Mortensen, T. 1927. *Handbook of the Echinoderms of the British Isles*. Oxford University Press: London. 471 pp.
- Ohshima, H. 1915. Report of the holothurians collected by the United States Fisheries Steamer *Albatross* in the northwestern Pacific during the summer of 1906. *Proceedings United States National Museum* 48: 213–91, pls 8–11.
- Oken, L. 1815. *Lehrbuch der Naturgeschichte*. 3. Zoologie. Jena: Germany. Pp. xxxviii+850+xxviii.
- O'Loughlin, P.M. 2000. A review of the cucumariid genus *Psolidiella* Mortensen (Echinodermata, Holothuroidea). *Memoirs of Museum Victoria* 58: 25–37.
- O'Loughlin, P.M., and O'Hara, T.D. 1992. New cucumariid holothurians (Echinodermata) from southern Australia, including two brooding and one fissiparous species. *Memoirs of the Museum of Victoria* 53: 227–66.
- Pawson, D.L. 1964. The Holothuroidea collected by the Royal Society Expedition to Southern Chile, 1958–1959. *Pacific Science* 18(4): 453–70.
- Pawson, D.L. 1967. The psolid genus *Lissothuria*. *Proceedings of the United States National Museum* 122(3592): 1–17.
- Pawson, D.L. 1968a. Some holothurians from Macquarie Island. *Transactions of the Royal Society of New Zealand (Zoology)* 10(15): 141–50.
- Pawson, D.L. 1968b. The echinozoan fauna of the New Zealand subantarctic islands, Macquarie Island, and the Chatham Rise. *Bulletin of the New Zealand Department of Scientific and Industrial Research* 187: 9–33, 3 figs, 1 pl.
- Pawson, D.L. 1968c. A new psolid sea cucumber from the Virgin Islands. *Proceedings of the Biological Society of Washington* 81: 347–50.
- Pawson, D.L. 1969a. Holothuroidea from Chile. Report No. 46 of the Lund University Chile Expedition 1948–1949. *Sarsia* 38: 121–45.
- Pawson, D.L. 1969b. Holothuroidea. Pp. 36–38, 1 pl. in: Bushnell, V.C., and Hedgpeth, J.W. (eds), *Distribution of Selected Groups of Marine Invertebrates in Waters South of 35° S Latitude. Antarctic Map Folio Series (II)*. American Geographical Society: New York.
- Pawson, D.L. 1970. The marine fauna of New Zealand: Sea cucumbers (Echinodermata: Holothuroidea). *Bulletin of the New Zealand Department of Scientific and Industrial Research* 201: 7–65, 10 figs, 2 pls.
- Pawson, D.L. 1971a. The Western Australian psolid holothurian *Cetocuvieria* (Cuvier). *Journal of the Royal Society of Western Australia* 54(2): 33–39.
- Pawson, D.L. 1971b. *Ekkentropelma brychia* n.g., n.sp., an Antarctic psolid holothurian with a functionally lateral sole. *Proceedings of the Biological Society of Washington* 84(14): 113–18.
- Pawson, D.L. 1982. Holothuroidea. Pp. 813–18; figs pp. 791, 792; pls 136, 137 in: Parker, S.P. (ed.-in-chief), *Synopsis and Classification of Living Organisms*. McGraw-Hill: New York.

- Pawson, D.L., and Fell, H.B. 1965. A revised classification of the dendrochirote holothurians. *Breviora* 214: 1–7.
- Pawson, D.L. and Valentine, J.F. 1981. *Psolidium prostratum*, new species, from off the east coast of the USA. (Echinodermata: Holothuroidea). *Proceedings of the Biological Society of Washington* 94(2): 450–54.
- Perrier, R. 1902. Holothuries. Pp. 273–554, pls 12–22 in *Expéditions scientifiques du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883*. Masson et Cie, Éditeurs: Paris.
- Perrier, R. 1905. Holothuries antarctiques du Muséum d'Histoire Naturelle de Paris. *Annales des Sciences Naturelles. Zoologie* 1: 1–146, 5 pls.
- Philippi, A. 1857. Vier neue Echinodermen des Chilenschen Meeres. *Archiv Naturgeschichte* 23: 130–34.
- Rowe, F.W.E. 1982. Sea-cucumbers (class Holothuroidea). Pp. 454–76, figs 10:26–10:37, pls 29–32 in: Shepherd, S.A., and Thomas, I.M. (eds), *Marine Invertebrates of Southern Australia*. Part 1. South Australian Government Printer: Adelaide.
- Rowe, F.W.E., and Gates, J. 1995. Echinodermata. In: Wells, A. (ed.), *Zoological Catalogue of Australia* 33: i–xiii, 1–510. CSIRO: Melbourne.
- Selenka, E. 1868. Nachtrag zu den Beiträgen zur Anatomie und Systematik der Holothurien. *Zeitschrift Wissenschaftliche Zoologische* 18: 109–19, pl. 8.
- Semper, C. 1868. Holothurien. *Reisen im Archipel der Philippinen*. 2. *Wissenschaftliche Resultate. Erster Band*. Engelmann: Leipzig. 288 pp., 40 pls.
- Sluiter, C.P. 1901. Die Holothurien der Siboga-Expedition. *Siboga-Expédition* 44: 1–142, 10 pls. Buchhandlung en Druckerei v. E. J. Brill: Leiden.
- Studer, T. 1876. Über Echinodermen aus dem antarktischen Meere und zwei neue Seeigel von den Papua-Inseln, gesammelt auf der Reise SMS *Gazelle* um die Erde. *Monatsberichte der Königlich Preussischen Akademie der Wissenschaften*. Berlin. Pp. 452–65.
- Thandar, A.S. 2006. New species and new records of dendrochirotid and dactylochirotid holothuroids (Echinodermata: Holothuroidea) from off the east coast of South Africa. *Zootaxa* 1245: 1–51.
- Théel, H. 1886. Report on the Holothuroidea dredged by HMS *Challenger* during the years 1873–1876. *Report on the scientific results of the voyage of HMS Challenger*, *Zoology* 14(39): 1–290, 16 pls.
- Tommasi, L.R. 1969. Lista dos Holothuroidea recentes do Brasil. *Contribuições Avulsas Instituto Oceanográfico, São Paulo* 15: 1–29.
- Tommasi, L.R. 1971. Echinodermes do Brasil. I. *Sobre algumas espécies novas e outras pouco conhecidas para o Brasil*. *Boletim Instituto Oceanográfico, São Paulo* 20(1): 1–23.
- Vaney, C. 1906. Holothuries. *Expédition Antarctique Française (1903–1905). Sciences Naturelles: Documents Scientifiques*. Masson et Cie, Éditeurs: Paris. 30 pp., 2 pls, 1 map.
- Vaney, C. 1914. Holothuries. *Deuxième Expédition Antarctique Française (1908–10). Sciences Naturelles: Documents Scientifiques*. Masson et Cie, Éditeurs: Paris. 54 pp., 5 pls.
- Verrill, A.E. 1866. On the Polyps and Echinoderms of New England. *Proceedings of the Boston Society of Natural History* 10: 333–57.
- Verrill, A.E. 1867. Notes on the echinoderms of Panama and the west coast of America, with descriptions of new genera and species. *Transactions of the Connecticut Academy of Arts and Sciences* 1(2): 251–322.



Antarctic and Sub-Antarctic species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae)

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Abstract

O'Loughlin, P.M., and Ahearn, C. 2008. Antarctic and Sub-Antarctic species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 65: 23–42.

Five new species of *Psolidium* Ludwig from Antarctica and Sub-Antarctica are described: *Psolidium emilyae* sp. nov., *P. normani* sp. nov.; *P. pawsoni* sp. nov.; *P. schnabelae* sp. nov.; *P. whittakeri* sp. nov. *Psolidium incertum* (Théel) is a junior synonym of *Psolidium poriferum* (Studer). *Psolidium tenue* Mortensen is raised out of synonymy with *P. incertum*. Six species of *Psolidium* Ludwig from Antarctica and Sub-Antarctica are diagnosed: *P. disciformis* (Théel); *P. dorsipes* Ludwig; *P. gaini* Vaney; *P. incubans* Ekman; *P. poriferum* (Studer); *P. tenue* Mortensen. A key is provided for the 11 Antarctic and Sub-Antarctic species of *Psolidium* Ludwig.

Keywords

Echinodermata, Holothuroidea, Psolidae, *Psolidium*, taxonomy, new species, key

Introduction

This study is based on the extensive collections of Antarctic and Sub-Antarctic holothuroids held in the National Museum of Natural History (NMNH) of the Smithsonian Institution in Washington DC, the New Zealand Oceanographic Institute (NZOI, now National Institute of Water and Atmospheric Research [NIWA]), and Museum Victoria (NMV), South Australian Museum (SAM) and Tasmanian Museum and Art Gallery (TMAG) in Australia. The material is representative of the Antarctic Ocean off both Eastern and Western Antarctica, and the Sub-Antarctic Islands in the Atlantic, Indian and Pacific oceans. The NMNH collection came from the United States Fish Commission *Albatross* expeditions, and the United States Antarctic Research Program (USARP), and collections by the research vessels *Eastwind*, *Edisto*, *Eltanin*, *Glacier*, *Hero* and *Islas Orcadas* (See O'Loughlin and Ahearn, 2005). The NIWA collections were made in the Ross Sea region by the research vessels *Endeavour* and *Tangaroa*. The NMV and SAM collections came from the Australian National Antarctic Research Expedition (ANARE), and were collected by the research vessels *Aurora Australis* and *Nella Dan*. Heard Island collections in TMAG were made for the Australian Antarctic Division by F/V *Southern Champion*. Some BANZARE holothuroids remained on loan to USNM, and were included in our study. Some specimens from the British Museum (The Natural History Museum) (BM[NH]) that were

collected by the *Discovery*, *Challenger* and *William Scoresby* were also available for our study. Some specimens taken by R/V *Vema* were donated to NMNH by the American Museum of Natural History. Recently collected holothuroids were donated to NMV from the AMLR R/V *Yuhz-morgeologiya* (2003) and *Icefish* (2004) expeditions to the southern Atlantic. Holothuroid specimens and data collected recently by the New Zealand International Polar Year Census of Antarctic Marine Life Project expedition to the Ross Sea by R/V *Tangaroa* were made available for collaborative study at NIWA in Nelson (New Zealand). The type specimen for *Psolidium poriferum* (Studer, 1876) was borrowed from the Humboldt-Universitaet museum für naturkunde in Berlin (ZMB).

We have reviewed the systematics of species of *Psolidium* Ludwig, 1886, described to date from Antarctica and Sub-Antarctica, and recognise six species. O'Loughlin (2002) has previously synonymised *Psolidium navicula* Ekman, 1927, and *Psolidium bistriatum* Ludwig and Heding, 1935, with *Psolidium (Cucumaria) coatsi* Vaney, 1908, and referred *P. coatsi* to his new genus *Psolicrux* O'Loughlin, 2002. We have added five new species of *Psolidium* from Bouvet Island, South Sandwich Islands, South Shetland Islands, Weddell Sea, Ross Sea, Prydz Bay and Enderby Land. In the past some specimens from Antarctica and Sub-Antarctica have been determined as *Psolidium incertum* (Théel, 1886). These specimens, that are similar morphologically, represent a complex of five species.

Three are new and are described here. Two belong to previously described but unused or synonymised taxa: *Psolidium poriferum* (Studer, 1876) and *Psolidium tenue* Mortensen, 1925. Specimens of *Psolidium gaini* Vaney, 1914, showed significant variations in ossicle size and form and the possibility of another species complex is suggested. Molecular data will be an important additional source of evidence for further refinement of our work.

Preserved specimens of Psolidae typically have tentacles withdrawn, and there has been some historical reluctance to dissect to sample tentacles for ossicle study. We found tentacle ossicle form to be essential for diagnosis within the *Psolidium poriferum* species group. To assist in our diagnoses we describe “rod-plates”, derived from rods with branches joined or with side-connections to create perforations (Figures 6e, f). These are distinguished from smooth perforated plates that show no evidence of rod derivation.

Materials and methods

SEM and some digital photography were done by Cynthia Ahearn. Specimens were photographed directly using a Nikon Coolpix 995 digital camera with flash lighting. Ossicles were photographed using the same camera with a Wild M20-34504 compound microscope. SEM images were taken using a Leica Stereoscan 440 with LaB6 electron source. Some specimen photographs were taken by Leon Altoff and Audrey Falconer, with Mark O'Loughlin, using a Pentax K10D digital SLR with a variety of lenses and lit using two electronic flashes. Preserved specimens were placed on or suspended above black velvet. Photos of some ossicles were taken by Chris Rowley, with Mark O'Loughlin, using a Leica DM5000 B compound microscope, and Leica DC500 camera with montage software.

Specimen registration number prefixes are: NMV F, SAM K, TMAG H, USNM E or without prefix (See O'Loughlin and Ahearn, 2005).

Dendrochirotida Grube, 1840 (restricted Pawson and Fell, 1965)

Psolidae Forbes, 1841

Remarks. A synonymy and diagnosis for Psolidae are provided by O'Loughlin and Maric (2008). Pawson and Fell (1965), and subsequent authors, have nominated Perrier (1902) as the systematic author of Psolidae. We recognise Forbes (1841) as the original author.

Key to genera of Psolidae (See O'Loughlin and Maric, 2008)

Key to Antarctic and Sub-Antarctic species of *Psolidium* Ludwig, 1886

1. Mid-ventral (sole) radial series of tube feet present **2**
- Lacking mid-ventral (sole) radial series of tube feet **3**
2. Ossicles in sole include irregularly oval to round disc-like smooth plates, variably with few minute, closed to almost closed, perforations **4**
- *P. disciformis* (Théel, 1886) (S Chile)

- Irregularly oval to round, disc-like smooth plates, variably with few minute, closed to almost closed, perforations, not present in sole **5**
- *P. dorsipes* Ludwig, 1886 (S Chile, S Argentina, Strait of Magellan, Burdwood Bank, Falkland Is)
- 3. Dorsally with deep goblet-like cups, closed across rim, vertical spines above rim; brood-protects in folds of sole **6**
- *P. incubans* Ekman, 1925 (South Georgia)
- Dorsally lacking deep goblet-like cups closed across rim; no brood-protection in folds of sole **4**
- 4. Dorsal and lateral scales conspicuous; dorsal and lateral tube feet inconspicuous; lacking numerous dorsal and lateral tube feet support ossicles; crosses and small perforated plates rare to absent in sole **5**
- Dorsal and lateral scales inconspicuous; dorsal and lateral tube feet numerous and conspicuous; dorsal and lateral tube foot support ossicles numerous; sole with numerous perforated plates **9**
- 5. Largest tentacle trunk ossicles predominantly thick, narrow rod-plates and perforated plates with prominent rod thickenings **6**
- *P. tenue* Mortensen, 1925 (Antarctic Peninsula, Ross Sea, Wilkes Land, Antipodes I., Prydz Bay)
- Largest tentacle trunk ossicles predominantly smooth perforated plates **6**
- 6. Dorsal scales frequently with well-developed, radiating-to-margin, linear, rounded thickenings between rows of marginal perforations **7**
- *P. poriferum* (Studer, 1876) (Marion, Kerguelen, Heard, McDonald Is; MacRobertson Land)
- Dorsal scales rarely with linear thickenings between rows of marginal perforations **7**
- 7. Dorsal scales frequently with smooth white thickening; perforations reduced, many almost closed **8**
- *P. pawsoni* sp. nov. (Weddell Sea, Ross Sea, Enderby Land)
- Dorsal scales with irregular lumpy or reticulate thickening, rarely with smooth white thickening and almost closed perforations **8**
- 8. Largest tentacle trunk ossicles predominantly plates with large irregular perforations **9**
- *P. whittakeri* sp. nov. (South Sandwich, Bouvet, South Shetland Islands)
- Largest tentacle trunk ossicles predominantly plates with large perforations centrally grading to numerous small close perforations marginally **10**
- *P. schnabelae* sp. nov. (off Prydz Bay, MacRobertson Land)
- 9. Ossicles in sole numerous crosses; rare perforated plates **10**
- *P. emilyae* sp. nov. (Prydz Bay)
- Ossicles in sole perforated plates **10**

10. Dorsal scales single-layered only perforated plates; perforated plates in sole lacking irregular thickenings
P. gaini Vaney, 1914 (South Georgia, S Orkney Is, Weddell Sea, Antarctic Peninsula, Ross Sea, Prydz Bay)
- Dorsal scales single-layered with some secondary layering; sole with irregularly thickened, scale-like perforated plates
P. normani sp. nov. (Adelie Land, Prydz Bay, MacRobertson Shelf, Enderby Land)

Table 1. Distribution of Antarctic and Sub-Antarctic species of *Psolidium* Ludwig, 1886.

<i>Psolidium</i> species	Distribution
<i>P. disciformis</i> (Théel, 1886)	Chile, Comau Fjord to Strait of Magellan; 8–448 m
<i>P. dorsipes</i> Ludwig, 1886	S Argentina, Falkland Is, S Chile; 10–483 m
<i>P. emilyae</i> sp. nov.	E Antarctica, Prydz Bay, Four Ladies Bank; 450–556 m
<i>P. gaini</i> Vaney, 1914	South Georgia to Ross Sea to Prydz Bay; 19–646 m Weddell Sea; 260–795 m (Gutt, 1988)
<i>P. incubans</i> Ekman, 1925	South Georgia, Cumberland Bay; 12–38 m
<i>P. normani</i> sp. nov.	Adelie Land, Prydz Bay, Enderby Land; 105–193 m
<i>P. pawsoni</i> sp. nov.	Weddell Sea, Ross Sea, Enderby Land; 137–920 m
<i>P. poriferum</i> (Studer, 1876)	Marion, Kerguelen, Heard, McDonald Is; 100–600 m Eastern Antarctica, MacRobertson Land; 177 m
<i>P. schnabelae</i> sp. nov.	MacRobertson Land, slope off Prydz Bay; 1266 m
<i>P. tenue</i> Mortensen, 1925	Antarctic Peninsula to Ross Sea to Prydz Bay; 90–923 m New Zealand, Antipodes I.; 2010–2100 m
<i>P. whittakeri</i> sp. nov.	Bouvet, S. Sandwich, S. Shetland Is; 146–759 m

Psolidium Ludwig

Psolidium Ludwig, 1886: 9.—Mortensen, 1927: 413.—Deichmann, 1941: 141–43.—Deichmann, 1947: 336.—Lambert, 1996: 21.

Diagnosis (see O’Loughlin and Maric, 2008). Dendrochirotid holothuroids; small, up to 40 mm long; mid-body arched dorsally in transverse section, flat ventrally; dorsal and lateral body covered with imbricating scales, usually macroscopically conspicuous, irregular in size and arrangement; scales decreasing in size ventro-laterally, orally and anally; lacking large oral valves; extensible oral cone, anterior to anterior-dorsal to dorsal orientation; extensible anal cone, posterior to

posterior-dorsal to dorsal orientation; tube feet dorsally and laterally in mid-body, pass through scales.

Sole distinct, oval to elongate; discrete margin created by junction of small imbricating ventro-lateral scales with thin-walled, usually calcareous, sole that lacks scales; peripheral band of tube feet, may be discontinuous across the inter-radii anteriorly and posteriorly; peripheral tube feet frequently of 2 sizes, outer series smaller; mid-ventral radial series of tube feet present or absent.

Calcareous ring solid, plates sub-rectangular, radial and interradiial plates with tapered anterior projections; radial plates with deep notch posteriorly, interradiial plates with shallow concave indentation posteriorly; 10 dendritic tentacles, ventral 2 smaller.

Dorsal and lateral ossicles: multi-layered or single-layered perforated plates (scales), always some with tube foot canals; integument covering scales may have cupped crosses, cups, “thorn” ossicles (irregular branched rods pointed distally), buttons, perforated plates and rosettes; tube foot small endplates, and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Sole ossicles: inter-radii with small to large single-layered perforated plates (rarely with multi-layering), smooth to variably knobbed and thickened, sometimes with cupped crosses, cups, thorn ossicles, and rosettes; radii with additional tube foot ossicles, large endplates and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Tentacle ossicles: perforated plates, rod-plates and rods, thick to thin, long to short, straight or bent, flat or curved; dendritic tentacle branch endplates are small, irregular in shape, cupped, with a few large perforations and irregular margin; densely branched rosettes may be present.

Type species. *Psolidium dorsipes* Ludwig, 1886.

Antarctic and Sub-Antarctic species. *Psolidium disciformis* (Théel, 1886); *P. dorsipes* Ludwig, 1886; *P. emilyae* sp. nov.; *P. gaini* Vaney, 1914; *P. incubans* Ekman, 1925; *P. normani* sp. nov.; *P. pawsoni* sp. nov.; *P. poriferum* (Studer, 1876); *P. schnabelae* sp. nov.; *P. tenue* Mortensen, 1925; *P. whittakeri* sp. nov.

Psolidium disciformis (Théel)

Figures 1a, b; 4a

Psolus disciformis Théel, 1886: 85, pl. 9 fig. 6.

Theelia disciformis.—Ludwig, 1892: 350.—Perrier, 1902: 494.

Theelia (?*Psolidium*) *disciformis*.—Ludwig, 1894: 136.—Ludwig, 1898: 52.

Psolidium disciformis.—Deichmann, 1947: 337.—Pawson, 1969: 38, map 3.

Material examined. Syntypes (2): Chile, *Challenger* stn 311, 52°45’30”S 73°46’W, 448 m, BM(NH) [18]86.10.2.86.

Diagnosis. *Psolidium* species up to 18 mm long (25 mm in Théel, 1886); dorsal and lateral scales conspicuous, up to 1 mm wide; dorsal and lateral tube feet numerous, conspicuous, up to 2 penetrate each scale.

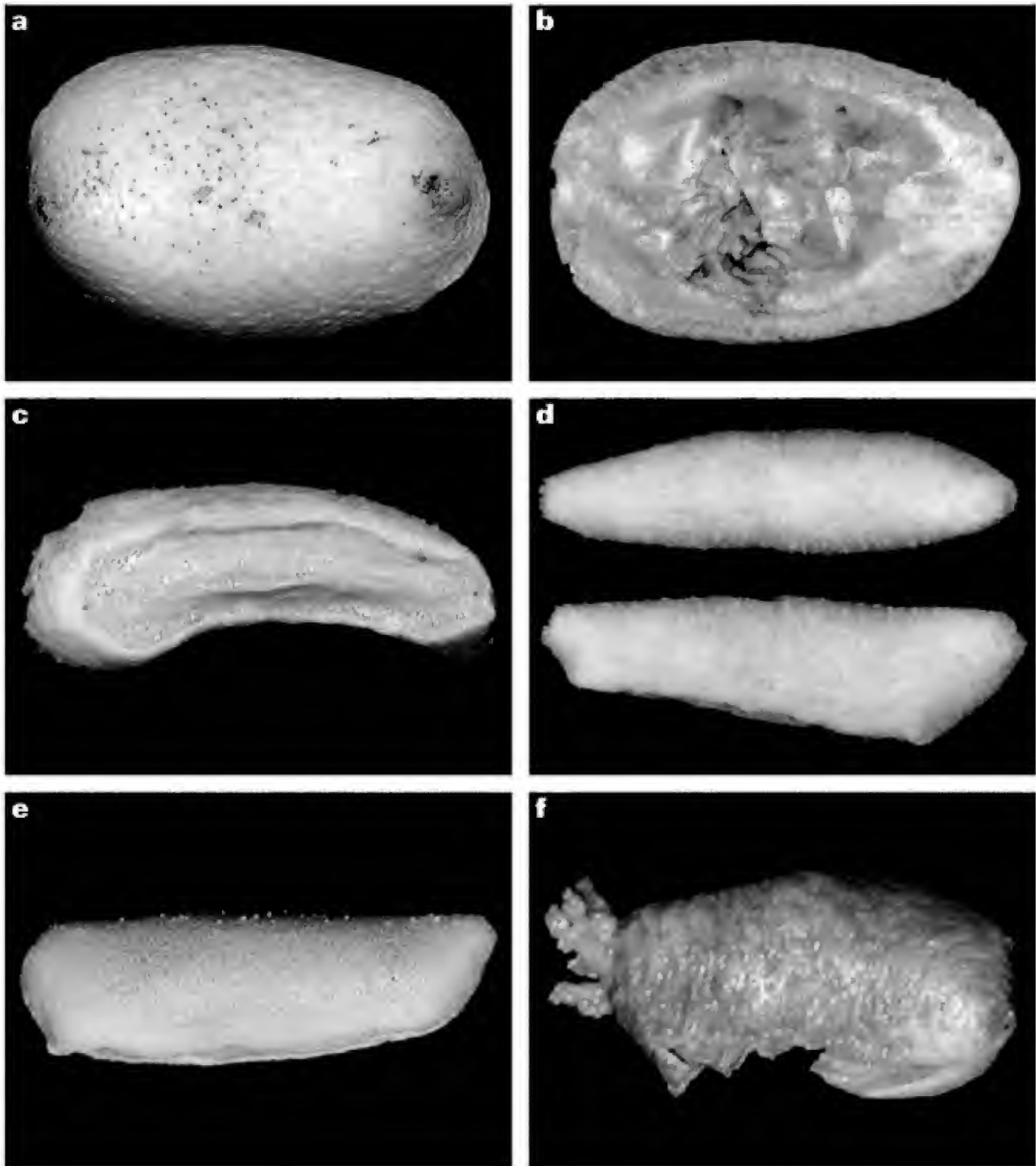


Figure 1. Photos of preserved specimens of species of *Psolidium* Ludwig, 1886 (a–c, e, f, by Cynthia Ahearn; d, by Leon Altoff and Audrey Falconer). a, b, *P. disciformis* (Théel, 1886), Chile, 18 mm long, holotype BM(NH) [18]86.10.2.86: a, dorsal; b, ventral. c, *P. dorsipes* Ludwig, 1886, Argentina, ventral, 14 mm long, USNM 1114252. d, *P. emilyae* sp. nov., Prydz, Bay, dorsal (above) and lateral (oral end right), 14 mm long, holotype SAM K2221. e, *P. gaini* Vanev, 1914, Victoria Land, lateral, 25 mm long, USNM E40556. f, *P. incubans* Ekman, 1925, South Georgia, lateral, 8 mm long, BM(NH) 2008.3190.

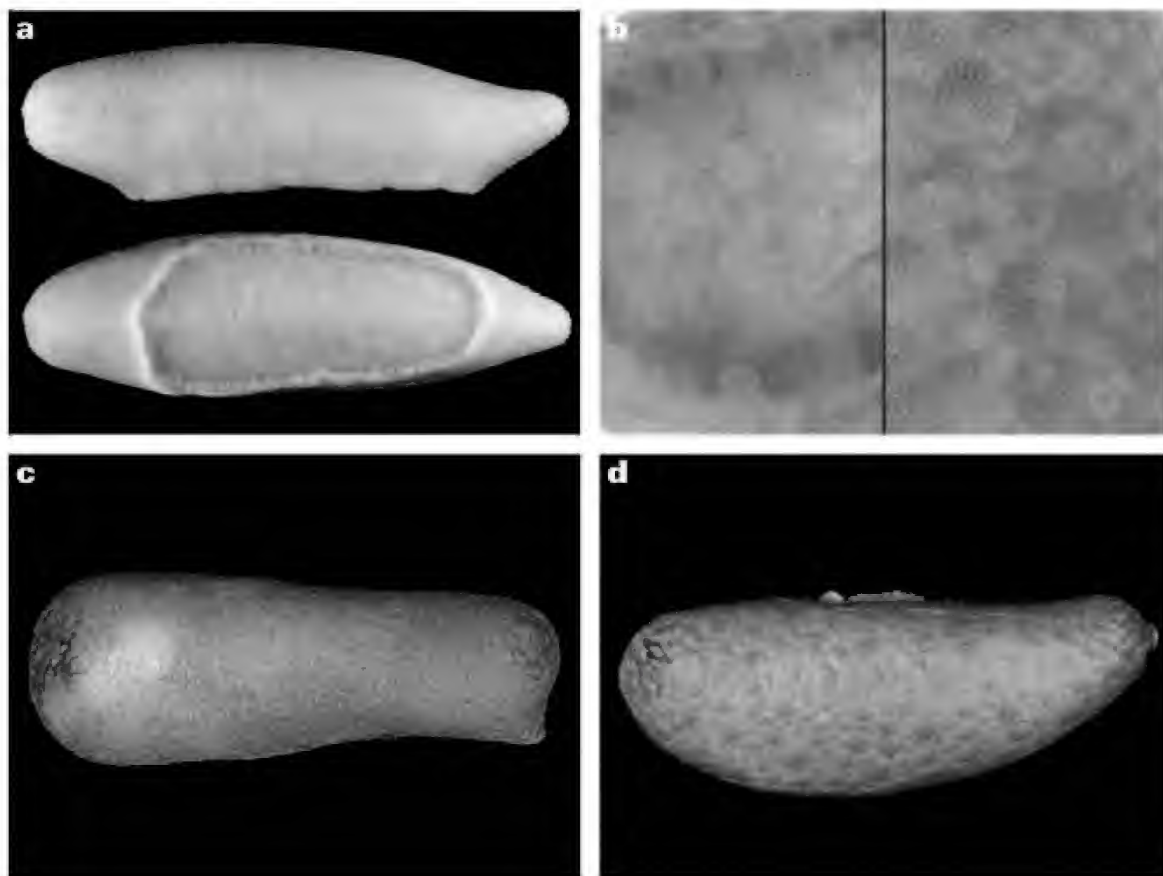


Figure 2. Photos of preserved specimens of species of *Psolidium* Ludwig, 1886 (a, b, by Leon Altoff and Audrey Falconer; c, by Cynthia Ahearn; d, by Mark Darragh). a, b, *P. normani* sp. nov., Prydz Bay: a, lateral (above) and ventral, 24 mm long, holotype NMV F157400; b, close-up of sole with scale-like plates (left), and of lateral scales (right), specimen 13 mm long, paratype NMV F69118. c, *P. pawsoni* sp. nov., Weddell Sea, dorso-lateral, 23 mm long, holotype, USNM 1112364. d, *P. poriferum* (Studer, 1876), Kerguelen I., dorsal, 20 mm long, holotype ZMB 2259.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; zig-zag series of mid-ventral (sole) radial tube feet.

Sole ossicles: numerous irregularly oval to round, disc-like smooth plates, variably with few small perforations, up to 220 μ m long; rare shallow cupped crosses and more numerous 4-holed regular shallow cups with blunt marginal spines, cups 150 μ m long.

Colour (live). White (P. Lambert, pers. comm.).

Distribution. SE Pacific Ocean, Chile, Comau Fiord to Strait of Magellan (42° to 56°S), on rock; 8–448 m (P. Lambert, pers. comm.).

Remarks. Théel (1886) noted the presence of dorsal and lateral tube feet in his new species, but Ludwig (1886) erected the genus

Psolidium for Psolidae with this diagnostic character in the same year. Deichmann (1947) assigned *Psolus disciformis* Théel, 1886, to *Psolidium* Ludwig, 1886. The form of the ossicles in the sole is diagnostically distinctive, and ossicles from dorsum and tentacles were not examined. Recent intensive field work on the Chilean coast under the auspice of the San Ignacio del Huinay Foundation has discovered an abundance of *P. disciformis* on the rocks in the coastal shallow from 8 to 27 m (P. Lambert, pers. comm.).

Psolidium dorsipes Ludwig

Figures 1c; 4b

Psolidium dorsipes Ludwig, 1886: 9–10, pl. 2, fig. 9.—Ludwig, 1892: 349.—Ludwig, 1894: 135 (*passim*).—Perrier, 1904: 16.—Perrier, 1905: 48, pl. 2 figs 5–15, text figs G–H.—Ekman, 1925: 112–13, text fig. 26.—Deichmann, 1941: 142–44, pl. 29 figs 1–12.—Deichmann, 1947:



Figure 3. Photos of preserved specimens of species of *Psolidium* Ludwig, 1886 (a, b, by Cynthia Ahearn; c-f, by Leon Altoff and Audrey Falconer). a, *P. schnabelae* sp. nov., Prydz Bay, dorso-lateral (oral end right), 26 mm long, holotype SAM K2345. b–d, *P. whittakeri* sp. nov.: b, South Sandwich Is, ventral, 28 mm long, holotype USNM 1112365; c, Deception I., lateral, 28 mm long, NMV F104834; d, tentacles, specimen 28 mm long, NMV F104834. e, f, *P. tenue* Mortensen, 1925, Prydz Bay, 28 mm long (two ventral small, bottom), NMV F107416; e, lateral; f, sole.

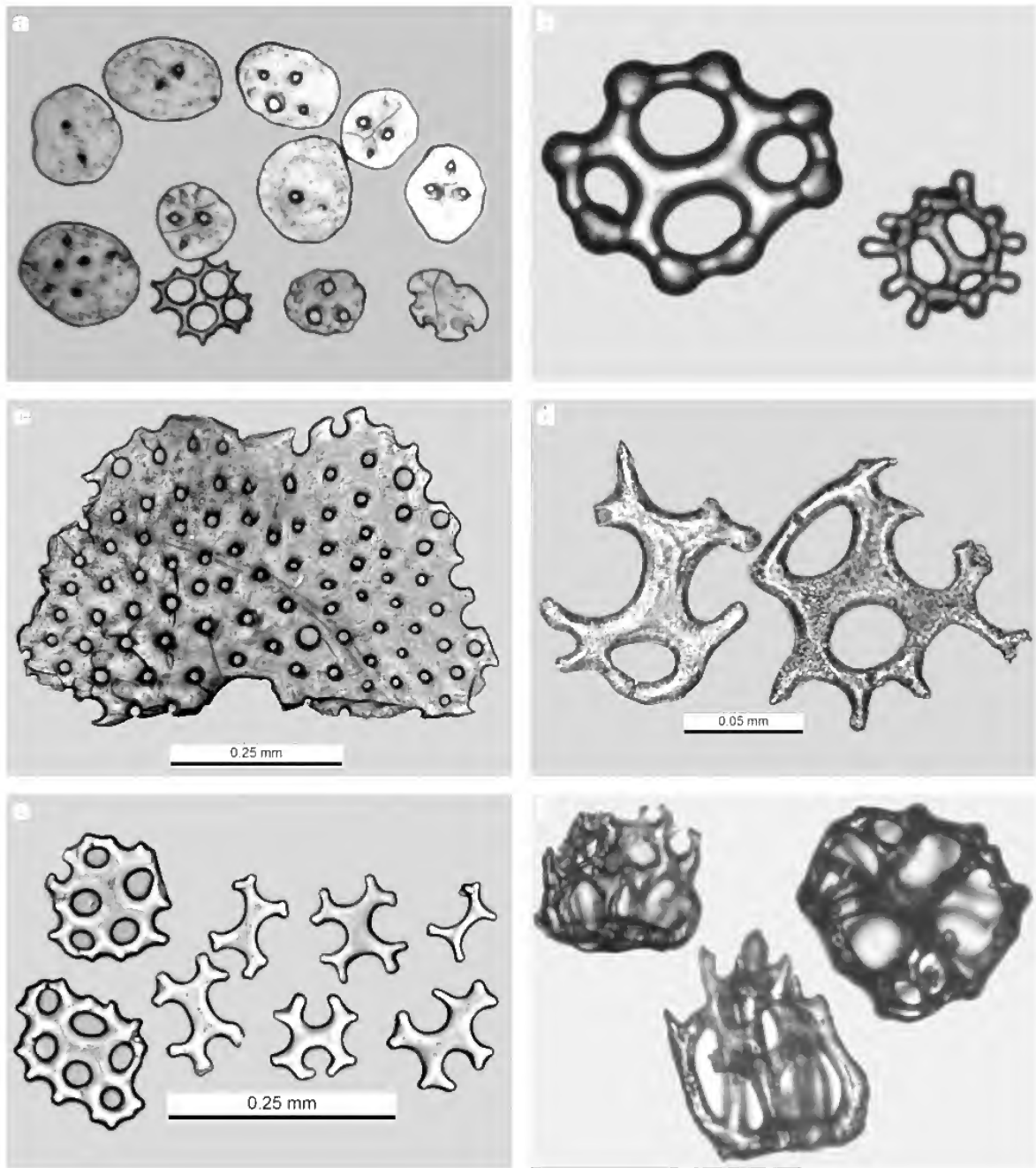


Figure 4. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a, b, f, by Cynthia Ahearn; c–e, by Chris Rowley). a, *P. disciformis* (Théel, 1886), shallow cup (bottom centre left, 150 μ m long) and disc-like plates from sole, holotype BM(NH) [18]86.10.2.86. b, *P. dorsipes* Ludwig, 1886, button (left, 90 μ m long) and cup from sole, USNM 1114251. c–e, *P. emilyae* sp. nov., holotype SAM K2221: c, dorsal scale; d, dorsal tube foot support plates; e, crosses and plates from sole. f, *P. incubans* Ekman, 1925, deep goblet-like dorsal cups, 70–90 μ m wide, 80–110 μ m high, BM(NH) 2008.3190.

336–37.—Hickman, 1962: 60.—Pawson, 1969: 38, map 3.—Pawson and Valentine, 1981: 453.—Lambert, 1996: 28–30, table 1.

Material examined. South Atlantic Ocean, Argentina, Santa Cruz, E of Grande Bay, 92 m, USNM E2177 (2 specimens); E of Cabo Virgenes, 101 m, USNM 1114251 (5); near Strait of Magellan, 66 m, 1114252 (1); Tierra del Fuego, Staten I., E40823 (2); Cape Penas, 81 m, E40824 (2); R/V *William Scoresby* stn 834, Cape Virgenes, 0–38 m, BM(NH) 2008.3182 (1); Scotia Sea, E of Burdwood Bank, 419–483 m, E40825 (1).

South Pacific Ocean, Chile, Strait of Magellan, 36 m, E2178 (4); Cape Froward, 82 m, USNM 1081593 (1).

Diagnosis. *Psolidium* species up to 17 mm long; preserved form variably with low to high profile, short to elongate oval sole; dorsal and lateral scales conspicuous, smooth, up to 1.6 mm wide; dorsal and lateral tube feet conspicuous, numerous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single to double series of larger tube feet; mid-ventral (sole) radial single to zig-zag to double series of tube feet.

Dorsal ossicles: multi-layered plates (scales) thick, 0–2 canals and 0–2 marginal indentations for tube feet per scale; intergrade with large thick knobbed plates with developing secondary layers; perforated plates with thickenings (buttons), 100–150 μm long, 3 to many perforations; thick smooth perforated plates, 150–200 μm long; numerous shallow cups, oval, marginally with round knobs, biggest cups knobbed on cross and rim, 2 large central and 2 smaller end perforations, cups 40–60 μm long.

Sole ossicles: shallow cups, oval, 2 large central and 2 smaller end perforations, some imperfectly formed, variably finely knobbed on margin to thickly knobbed on margin and cross, cups 40–70 μm long; thickly knobbed, regular, 4-holed buttons, 80–100 μm long, some irregular, up to 150 μm long; shallow concave perforated plates variably knobbed on surface and margin, up to 16 perforations, up to 200 μm long.

Distribution. Argentina (E of Grande Bay), Burdwood Bank, Falkland Is; Chile, Tierra del Fuego, Strait of Magellan; 10–483 m.

Remarks. One *Psolidium dorsipes* specimen (USNM 1114251) has shallow cup-shaped indentations covering the sole that appear to indicate brood-protection under the body.

Psolidium emilyae sp. nov.

Figures 1d; 4c–e

Material examined. Holotype: Eastern Antarctica, Prydz Bay, Four Ladies Bank, ANARE 1991, *Aurora Australis* stn 25B, 68°31'S 77°27'E, 450–556 m, K. L. Gowlett-Holmes and W. Zeidler, 3 Feb 1991, SAM K2221.

Diagnosis. *Psolidium* species 14 mm long (preserved); elongate tubular body, transversely rounded form, sole narrower than body width; dorsal and lateral tube feet conspicuous, numerous, cover body closely; dorsal and lateral scales inconspicuous.

Sole: peripheral single series of tube feet; some slightly smaller outer tube feet in an incomplete series (partly concealed by projecting ventro-lateral scales); lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: thick, smooth, single-layered perforated plates (scales), lacking secondary developments, small perforations, tube foot canals, scales up to 0.7 mm wide; irregular, curved tube foot support ossicles, up to 4 perforations, up to 128 μm long.

Sole ossicles: numerous crosses, predominantly regular, elongate, 4-armed, thick, with distal pairs of swellings on arms, branches rarely joined to create perforations, up to 144 μm long; few thick perforated plates, up to 10 perforations, margin variably bluntly toothed to slightly knobbed, up to 224 μm long.

Colour (preserved). Off-white.

Distribution. Eastern Antarctica, Prydz Bay, Four Ladies Bank; 450–556 m.

Etymology. Named for Emily Whitfield (Marine Research Group of the Field Naturalists Club of Victoria) who first noticed the distinctive cross ossicles in the sole of this species, and in appreciation of her research assistance in Museum Victoria.

Remarks. The cross ossicles in the sole of *Psolidium emilyae* sp. nov. are diagnostically distinctive among Antarctic and Sub-Antarctic *Psolidium* species, and tentacle ossicles from the unique small holotype specimen were not examined. *P. emilyae* is similar morphologically to *Psolidium normani* sp. nov. from Prydz Bay (see below), but the depth of occurrence of *P. normani* (105–193 m) is shallower than *P. emilyae* (450–556 m). A single specimen from Prydz Bay (98–301 m) of the morphologically similar *Psolidium gaini* Vaney, 1914, also occurred at a shallower depth than *P. emilyae*. Ossicles from the sole of specimens of *P. gaini* and *P. normani* that were similar in size to the small type specimen of *P. emilyae* were examined, and found to be similar to those in larger specimens of the two species, and not the crosses typical of *P. emilyae*.

Psolidium gaini Vaney

Figures 1e; 5a–c; 6a, b

Psolidium gaini Vaney, 1914: 18–20, pl. 1 figs 7–9, pl. 4 figs 6–14.—Ekman, 1925: 5, 117–19, text-fig. 28.—Ekman, 1927: 414–15.—Grieg, 1929a: 13.—Grieg, 1929b: 9.—Pawson, 1969: 38, map 3.—Arnaud 1974: 651.—Cherbonnier, 1974: 608.—Gutt, 1988: 23, 28, 30, 32, 65, 73, 77.—Gutt, 1991a: 147, 149, 152, 153.—Gutt, 1991b: 324.

Psolidium sp. MoV 2081.—O'Loughlin et al., 1994: 552, 554.

Material examined. Antarctic Ocean, South Orkney Is, 298–302 m, USNM E40558 (1 specimen); South Shetland Is, Aspland I., 163–180 m, AMLR-03 stn 90, 20 Mar 2003, NMV F104812 (2); Antarctic Peninsula, Joinville I., 210–220 m, USNM E40559 (10); Graham Land, 91 m, E40561 (2); Palmer Archipelago, 85–130 m, E40552 (2); 102 m, E40553 (1); 38–70 m, E40554 (2); 70–150 m, E40555 (2); 55 m, E40562 (1).

Ross Sea, *Terra Nova* stn 340, 76°56'S 164°12'E, 293 m, BM(NH) 1932.8.11.253 (2); NZOI *Endeavour* stns A461, 0–550 m, NIWA 43882 (1); A534, 366 m, NIWA 43884 (2); A537, 546 m, NIWA 43885 (1); E209B, 163 m, NIWA 43886 (2); *Discovery* stn 1660, Pennell Bank, 0–351 m, BM(NH) 2008.3183–3189 (7); *Tangaroa* stn 0802/100, 451–447 m, NIWA 45696 (4).

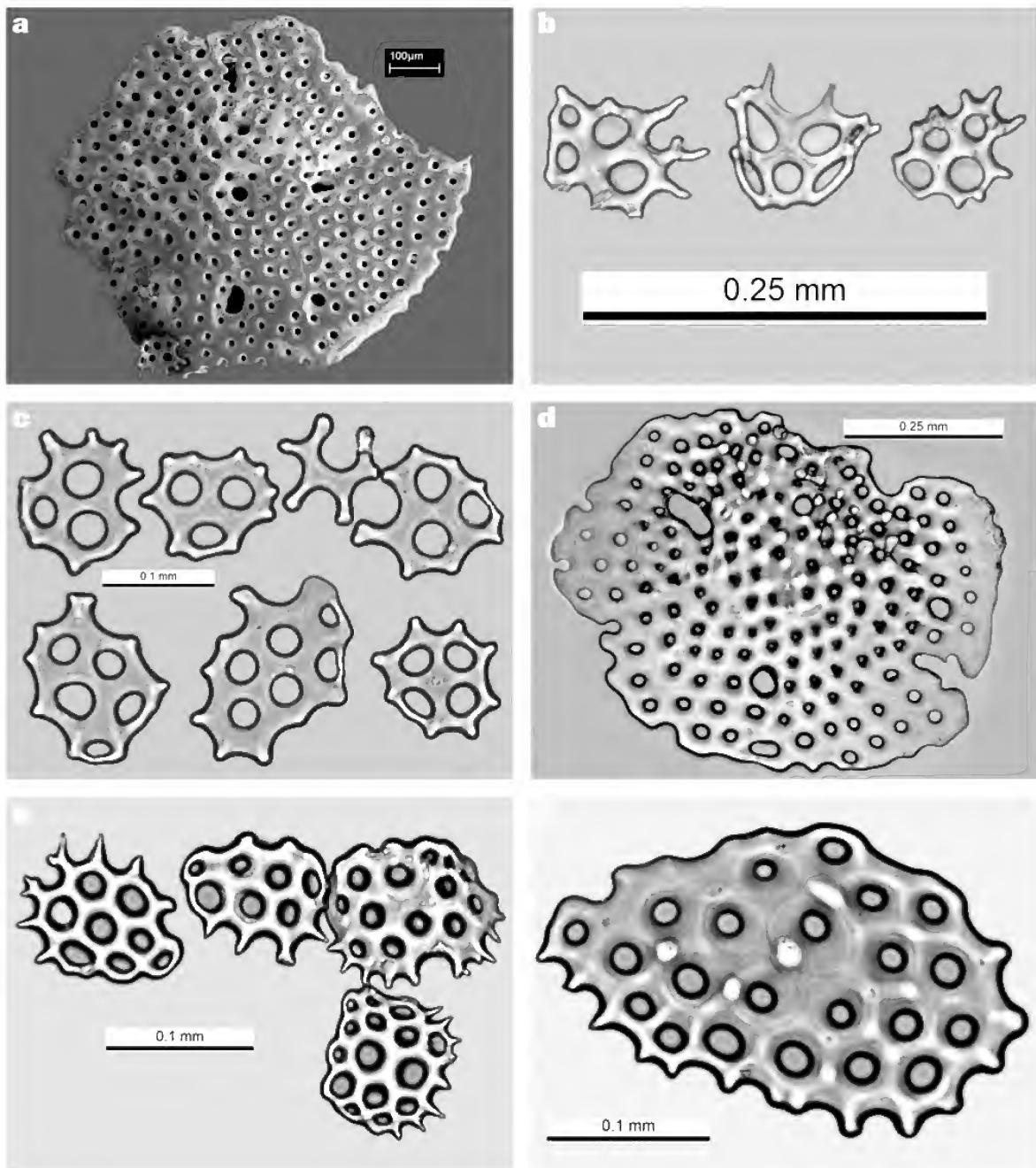


Figure 5. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a, SEM by Cynthia Ahearn; b–f, by Chris Rowley). a–c, *P. gaini* Vaney, 1914: a, dorsal scale and tube foot support plate (bottom left), USNM E40551; b, dorsal tube foot support plates, NMV F68112; c, plates from sole, NMV F68112. d–f, *P. normani* sp. nov.: d, dorsal scale, paratype SAM K2341; e, dorsal tube foot support plates, paratype NMV F68662; f, plate from sole, paratype SAM K2341.

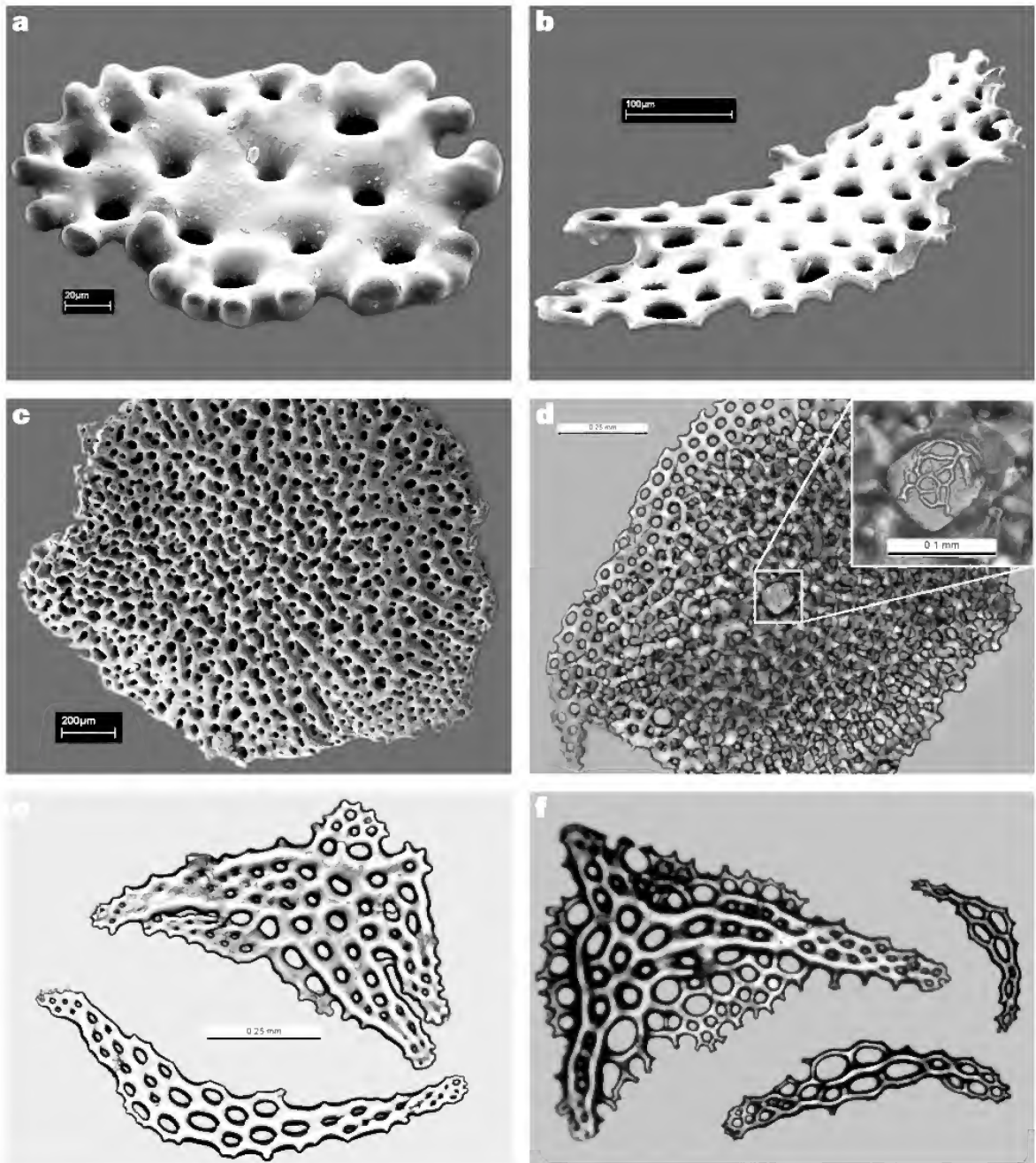


Figure 6. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a–c, SEM by Cynthia Ahearn; d, e, by Chris Rowley; f, by Cynthia Ahearn). a–b, *P. gaini* Vaney, 1914, USNM E40551: a, plate from sole; b, tentacle ossicle. c–f, *P. tenue* Mortensen, 1925: c, dorsal scale, USNM E40783; d, dorsal scale, with tube foot endplate in tube foot canal, and absence of tube foot support plates, NMV F107442; e, tentacle rod-plates, NMV F68113; f, tentacle rod-plates, largest 780 μ m long.

Victoria Land, 640–646 m, USNM E40556 (2); 598–613 m, E40560 (1); 573–576 m, USNM 1082084 (1); 598–613 m, USNM 1112624 (1); Balleny Is, 55–146 m, E40551 (19); 150–157 m, E40557 (1); *Tangaroa* stn 0602, 140–150 m, NIWA 44712 (1).

Adelie Land, BANZARE stn 90, 66°21'S 138°28'E, 640 m, SAM K2340 (1).

Prydz Bay, Four Ladies Bank, 298–301 m, NMV F68112 (1).

Diagnosis. *Psolidium* species up to 27 mm long (up to 40 mm in Vaney, 1914); body elongate, transversely rounded form (preserved), sole narrower than body width; dorsal and lateral tube feet conspicuous, numerous, cover body closely; dorsal and lateral scales inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: thick, smooth to irregularly thickened, single-layered, perforated plates (scales), up to 950 μ m long, perforations small, up to 3 canals or marginal indentations for tube feet per scale; irregular, asymmetrical, curved tube foot support plates, 4–8 perforations, digitiform to bluntly spinous (South Shetland Is) to pointed spines (Prydz Bay) on one margin, opposite margin lacking projections, plates up to 176 μ m long.

Sole ossicles: thick, regular, 4-holed buttons, variably knobbed to bluntly spinous marginally, 160–190 μ m long; intergrade with thick, smooth, perforated plates, sometimes slightly concave, sometimes slightly knobbed marginally, sometimes margin upturned, number of perforations variable, size of plates variable; plates up to 14 perforations, up to 184 μ m long, many knobbed marginally (South Shetland Is); plates up to 19 perforations, up to 255 μ m long (Ross Sea); plates up to 17 perforations, up to 224 (rarely 272) μ m long, slight swellings marginally (Prydz Bay).

Distribution. South Georgia, South Orkney Is, South Shetland Is, Weddell Sea, Antarctic Peninsula to Ross Sea to Prydz Bay; 19–795 m.

Remarks. Vaney (1914) reported the sizes of the two type specimens as 40 and 30 mm long. It is incongruous that none of the numerous specimens seen in this study is longer than 26 mm. Ekman (1925) noted some differences between the specimen that he examined and the description by Vaney (1914), and made a point that what Vaney described as “cups” dorsally, were for him tube foot support ossicles. We agree with Ekman (1925) that there are numerous tube foot support ossicles dorsally, that have the form of irregular curved perforated plates that are superficially cup-like. The dorsal and lateral tube feet in *Psolidium gaini*, *P. emilyae* sp. nov. (above) and *P. normani* sp. nov. (below) are conspicuous because of the presence of support ossicles, whereas the dorsal and lateral tube feet of *Psolidium poriferum* (below), *P. pawsoni* sp. nov. (below), *P. schnabelae* sp. nov. (below), *P. tenue* (below) and *P. whittakeri* sp. nov. (below) have at most rare tube foot support ossicles and are inconspicuous.

We noted plates from the sole of Antarctic Peninsula specimens (type region) up to 200 μ m long with up to 13 perforations. Sole plates from Adelie Land specimens were up to 300 μ m long with up to 23 perforations. Other variations are

noted in the diagnosis above. The variations are significant, and suggest that there may be more than one species.

Grieg (1929a, b) reported *Psolidium gaini* from South Georgia (55 m) and Graham Land (60–90 m), and noted reports of *P. gaini* from the South Shetland Is (19 m) and Emperor William Land (360 m). Gutt (1988) reported *P. gaini* from the Weddell Sea (260–795 m).

Psolidium incubans Ekman, 1925

Figures 1f; 4f

Psolidium incubans Ekman, 1925: 5, 113–116, text fig. 27.—Arnaud, 1974: 584. —Gutt, 1988: 73.

Material examined. South Georgia, *Discovery* stn MS67, E Cumberland Bay, 38 m, 28 Feb 1926, BM(NH) 2008.3190 (1 specimen).

Diagnosis. *Psolidium* species up to 12 mm long; wrinkled body surface, created by high cups; dorsal and lateral scales not conspicuous; dorsal and lateral tube feet conspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single to zig-zag to double series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet; sole soft, with folds for brood-protection.

Dorsal ossicles: perforated plates with anastomosing secondary developments and multi-layering (scales), up to 700 μ m long, 0–2 tube foot canals per scale; shallow cups with 2 large central and 2 smaller end perforations, marginal knobs, cups 90 μ m long; deep goblet-like cups closed across rim, vertical blunt spines above rim, cups 70–90 μ m wide, 80–110 μ m high.

Sole ossicles: shallow cupped crosses, shallow cups with small marginal knobs, cups 80 μ m long; shallow concave perforated plates, upturned marginal knobs, up to 14 perforations, plates up to 150 μ m long.

Distribution. South Georgia, Cumberland Bay; 12–38 m.

Remarks. As noted by Ekman (1925) this small species of *Psolidium* brood-protects in folds of the sole.

Psolidium normani sp. nov.

Figures 2a, b; 5d, f

Psolidium cf. *gaini*.—O'Loughlin et al., 1994: 552, 554 (non *Psolidium gaini* Vaney, 1914).

Material examined. Holotype: eastern Antarctica, MacRobertson Shelf, ANARE 1993, *Aurora Australis* stn 127, 67°16'S 65°26'E, 109–121 m, M. O'Loughlin, 12 Feb 1993, NMV F157400.

Paratypes: Type locality and date, F68661 (1 specimen); F69118 (1); Prydz Bay, Fram Bank, stn 130, 67°32'S 69°02'E, 105–114 m, F68662 (1); ANARE 1991, *Aurora Australis* stn 100, 67°28'S 68°50'E, 145–150 m, C. C. Lu and T. N. Stranks, 28 Feb 1991, F68111 (1); K. L. Gowlett-Holmes and W. Zeidler, SAM K2220 (1); Enderby Land, BANZARE stn 41, 65°48'S 53°16'E, 193 m, SAM K2341 (2); Adelie Land, BANZARE stn 90, 66°21'S 138°28'E, 640 m (possibly “much shallower”, according to BANZARE records), SAM K2349 (1).

Diagnosis. *Psolidium* species up to 30 mm long; body elongate, transversely rounded form (preserved), sole narrower than

body width; dorsal and lateral tube feet conspicuous, numerous, cover body closely; dorsal and lateral scales inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: predominantly single-layered perforated plates (scales), some secondary layering; up to 4 tube foot canals or marginal indentations per plate; scales up to 800 μm wide; numerous tube foot support plates, curved, spinous on one side (rarely both sides), marginal spines sometimes bifurcate, up to 19 perforations, up to 136 μm long; tube foot 'endplates' small irregular mesh-like, up to 48 μm wide, few perforations, irregular marginal projections, not regularly perforated plates.

Sole ossicles: scale-like perforated plates, intergrading with buttons with 4 perforations; plates bluntly to sharply spinous to knobbed on one side, projections sometimes bifurcate; pronounced surface thickenings with ridges or lumps; up to 48 perforations per plate; plates up to 352 μm long.

Distribution. Eastern Antarctica, Adelie Land; Prydz Bay, Fram Bank; MacRobertson Shelf; Enderby Land; 105–193 m (? 640 m).

Etymology. Named for Mark Norman (Senior Curator, Marine Biology Section, Museum Victoria), with admiration of his enthusiastic engagement with marine invertebrate studies, with gratitude for his personal support, and in recognition of his contribution to collecting from Prydz Bay and Heard I.

Remarks. *Psolidium normani* sp. nov. is similar externally to *P. emilyae* sp. nov. (above) and *P. gaini* Vaney, 1914, but is distinguished by the scale-like plates in the sole and secondary thickening of the dorsal scales.

***Psolidium pawsoni* sp. nov.**

Figures 2c; 7a, b

Psolidium incertum.—Gutt, 1988: 1, 3, 23, 27–77.—Gutt, 1991a: 147–153.—Gutt, 1991b: 315, 320, 324–25 (non *Psolidium incertum* (Th  el, 1886) = *Psolidium poriferum* (Studer, 1876) below).

Material examined. Holotype: Weddell Sea, Coats Land, Caird Coast, off Brunt Ice Shelf, USARP, R/V *Glacier*, cr 2 stn 1, 74  28'06"S 30  31'42"W, 513 m, 24 Feb 1969, USNM 1112364.

Paratypes: type locality and date, USNM E40798 (4); type locality and date, NMV F157430 (2).

Other material: Weddell Sea, 430 m, USNM E33925 (1).

Ross Sea, *Tangaroa* 0802, 67  69'S 170  E-178  W, 329–334 m, NIWA 38273 (1); 329–334 m, NIWA 38281 (1); 137–150 m, NIWA 38604 (1); 300–340 m, NIWA 38624 (6); 547–605, NIWA 39084 (12); 565–920 m, NIWA 39181 (2); 479–480 m, NIWA 39311 (6); 456–540 m, NIWA 45695 (8); 447–455 m, NIWA 45699 (1); *Tangaroa* 0602, stn 394, 67  S 179  E, 540–600, NIWA 44667 (5).

Enderby Land, BANZARE stn 34, 66  21'S 58  50'E, 603 m, SAM K2342 (2).

Diagnosis. *Psolidium* species up to 28 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 2.0 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally; plates frequently with smooth white thickening and reduced/small perforations aligned perpendicular to margin in parallel series; plates with reticulate thickening and multi-layered centrally, lacking frequent radiating linear thickenings between marginal perforations; up to 4 tube foot canals per plate; dorsal and lateral tube feet lacking support plates.

Sole ossicles: throughout most of sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, sometimes as regular 4-holed plates with marginal knobs or digitiform projections, sometimes surface knobs, up to 200 μm long; near margin of sole and peripheral tube feet thicker, irregular, elongate, perforated rod-plates, surface with pronounced linear thickenings (suggesting branched rod origin), up to 420 μm long, intergrading with oval to elongate thick perforated plates, slightly concave, some with secondary layering, up to 320 μm long.

Tentacles: largest tentacle trunk ossicles irregular round to oval to elongate, smooth perforated plates, some thin with large perforations, some thicker with smaller perforations, plates up to 550 μm long, rarely with any secondary layering; few narrow perforated plates, lacking evidence of rod derivation, up to 650 μm long.

Colour (preserved). Body pale brown to off-white; scales with slightly discontinuous haloes; fine red-brown microscopic flecking over dorsal body.

Distribution. Weddell Sea, 260–795 m (Gutt, 1991b); Ross Sea, 137–920 m; Enderby Land, 603 m.

Etymology. Named for Dr David Pawson (USNM, Senior Research Scientist), with gratitude for his provision of the opportunity to pursue this research, and appreciation of his constant interest and encouragement.

Remarks. Massin (1992) examined specimens of *Psolidium poriferum* (as *P. incertum*) from both the Sub-Antarctic islands of the Indian Ocean and the Weddell Sea, and observed that there were significant differences in the structure of the dorsal scales. He judged that the Weddell Sea material "probably represents another species". We agree, and refer the Weddell Sea, Ross Sea and Enderby Land material to *Psolidium pawsoni* sp. nov. Gutt (1988) reported *Psolidium incertum* (Th  el, 1886) from the Weddell Sea, and synonymised *Psolidium tenue* Mortensen, 1925, with *P. incertum*. We reject a synonymy of *P. incertum* with *P. tenue* (see our treatments of *P. poriferum* and *P. tenue*). We assume that the Weddell Sea material seen by Gutt is synonymous with our *Psolidium pawsoni* sp. nov. from the Weddell Sea, but acknowledge that *Psolidium tenue* might also occur in the Weddell Sea.

Psolidium pawsoni sp. nov. is distinguished diagnostically by the frequent occurrence on the dorsal and lateral scales of smooth white thickening with consequent reduced/small perforations.

***Psolidium poriferum* (Studer) syn. nov.**

Figures 2d; 7c-f

Cuvieria porifera Studer, 1876: 452–53.—Studer, 1879: 123.*Psolus poriferus*.—Bell, 1882: 644.—Lampert, 1889: 854.—Studer, 1889: 163.*Psolus poriferus* (*Cuvieria*).—Théel, 1886: 130.—Lampert, 1885: 122.*Psolus incertus* Théel, 1886: 86–87, pl. 8 fig. 4, pl. 6 fig. 5.—Studer, 1889: 163. (new synonymy).*Theelia incerta*.—Ludwig, 1892: 350.*Theelia* (? *Psolidium*) *incerta*.—Ludwig, 1894: 136.—Ludwig, 1898: 52.*Theelia porifera* (part).—Ludwig, 1898: 52.—Pawson, 1969: 38.*Psolidium incertum*.—Pawson, 1969: 38, map 3.—Pawson, 1971: 34, 37.—Guille, 1982: 70.—Massin, 1992: 317, 320–21, figs 8–9.—Branch, Jangoux, Alvá, Massin and Stampinato, 1993: 56, 61–65.—Thandar, 1999: 368.—Thandar, 2006: 38.*Psolidium poriferum*.—Pawson, 1971: 34, 37.—O'Loughlin and Maric, 2008: 3**Material examined.** *Psolidium poriferum* (Studer, 1876) holotype: Kerguelen, Royal Sound, *Gazelle*, 119 m, ZMB 2259.*Psolidium incertum* (Théel, 1886) syntypes (3; very poor condition): Kerguelen, Royal Sound, *Challenger* stn 149c, BM(NH) [18]86.10.2.89 (1); Heard I., stn 150, BM(NH) [18]86.2.88 (1); stn 151, BM(NH) [18]86.10.2.90 (1).Other material: Indian Ocean, McDonald Is, 210–234 m, USNM 1081576 (2 specimens); S of Kerguelen I., BANZARE stn 47, 150 m, SAM K2344 (23); Heard I., ANARE *Aurora Australis* AA90, 200 m, SAM K2189 (1); 260–380 m, K2190 (1); 260 m, K2191 (1); 266–380 m, K2205 (1); ANARE *Aurora Australis* AA92, 185–204 m, NMV F66849 (1); 229 m, F66850 (1); Heard I., F/V *Southern Champion*, cr SC26, Apr/May 2003, Western Plateau, 264–406 m, TMAG H3303 (1), H3306 (2), H3308 (2), H3317 (1), H3320 (4); Aurora Bank, 222–292 m, H3304 (4), H3305 (3), H3307 (4), H3309 (2), H3313 (2), H3314 (2), H3315 (1), H3318 (3), H3321 (6), H3322 (1); Coral Bank, 293–297 m, H3310 (3), H3311 (4); Shell Bank, 259–329 m, H3312 (1), H3316 (3), H3319 (2).

Eastern Antarctica, MacRobertson Land, BANZARE stn 107, 66°45'S 62°03'E, 177 m, SAM K2343 (1).

Diagnosis. *Psolidium* species up to 33 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 1.8 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, frequently with well developed radiating-to-margin linear rounded thickenings between series of perforations, reticulate thickenings towards centre of plates, multi-layered centrally; up to 3 tube foot canals per plate.

Sole ossicles: throughout most of sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, 0–10 perforations, bluntly spinous around margin, sometimes surface knobs, up to 220 μ m long; sometimes as regular 4-holed plates with marginal knobs, sometimes surface knobs, up to 160 μ m long; near margin of sole and peripheral tube feet some thicker, irregular perforated rod-plates, surface with linear thickenings and large knobs, rod-plates up to 370 μ m long, intergrading with oval to elongate perforated plates with secondary layering, up to 400 μ m long.Tentacles: largest tentacle trunk ossicles irregular round to triangular to oval, thick perforated plates, irregular large perforations, some small plates with secondary layering, plates up to 650 μ m long; some plates with irregular linear thickenings between perforations (suggesting rod origin), some rod-plates up to 800 μ m long.**Colour (preserved).** Body off-white; scales not haloed.**Distribution.** Marion, Prince Edward, Kerguelen, Heard and McDonald Is, 100–600 m (Massin, 1992), 150–406 m (this work); Eastern Antarctica, MacRobertson Land, 177 m.**Remarks.** Pawson (1971) indicated that the evidence was “quite strong” for a synonymy of *P. incertum* with *P. poriferum*, and O'Loughlin and Maric (2008, this volume) inferred this synonymy. Both species were described from the same type locality. Based on an examination of the type materials and the literature, *Psolidium incertum* (Théel, 1886) is synonymised here with *Psolidium poriferum* (Studer, 1876). *Psolidium poriferum* occurs abundantly on the Sub-Antarctic Islands of the Indian Ocean, with the exception of a single BANZARE specimen found on the MacRobertson Shelf on the Antarctic coast. *Psolidium poriferum* (Studer) is distinguished diagnostically by the frequent occurrence on the scales of well developed radiating-to-margin linear rounded thickenings between series of perforations.***Psolidium schnabelae* sp. nov.**

Figures 3a; 8a-c

Material examined. Holotype: Eastern Antarctica, MacRobertson Land, slope off Prydz Bay, BANZARE stn 29, 66°28'S 72°41'E, 1266 m, 25 Dec 1929, SAM K2345.

Other material: type locality and date, SAM K2346 (2).

Diagnosis. *Psolidium* species up to 25 mm long; body form elongate, high; dorsal and lateral scales conspicuous, thin, smooth, up to 2.5 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, reticulate thickenings extend from margin towards centre of plate, multi-layered centrally, lacking frequent radiating linear thickenings between marginal perforations, lacking smooth white thickening with small perforations, margin with irregular thickenings and perforations, not smooth; up to 4 tube foot canals or marginal indentations per plate; small mesh-like tube foot endplates, about 5 perforations, 40 μ m wide; lacking dorsal and lateral tube foot support plates.Sole ossicles: throughout sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, up to 10 perforations, up to 240 μ m long, sometimes as regular 4-holed plates with bluntly spined margin, sometimes surface knobs, up to 180 μ m long; near margin of sole and peripheral tube feet thicker irregular rod-plates and very thick irregular perforated plates, up to 300 μ m long.

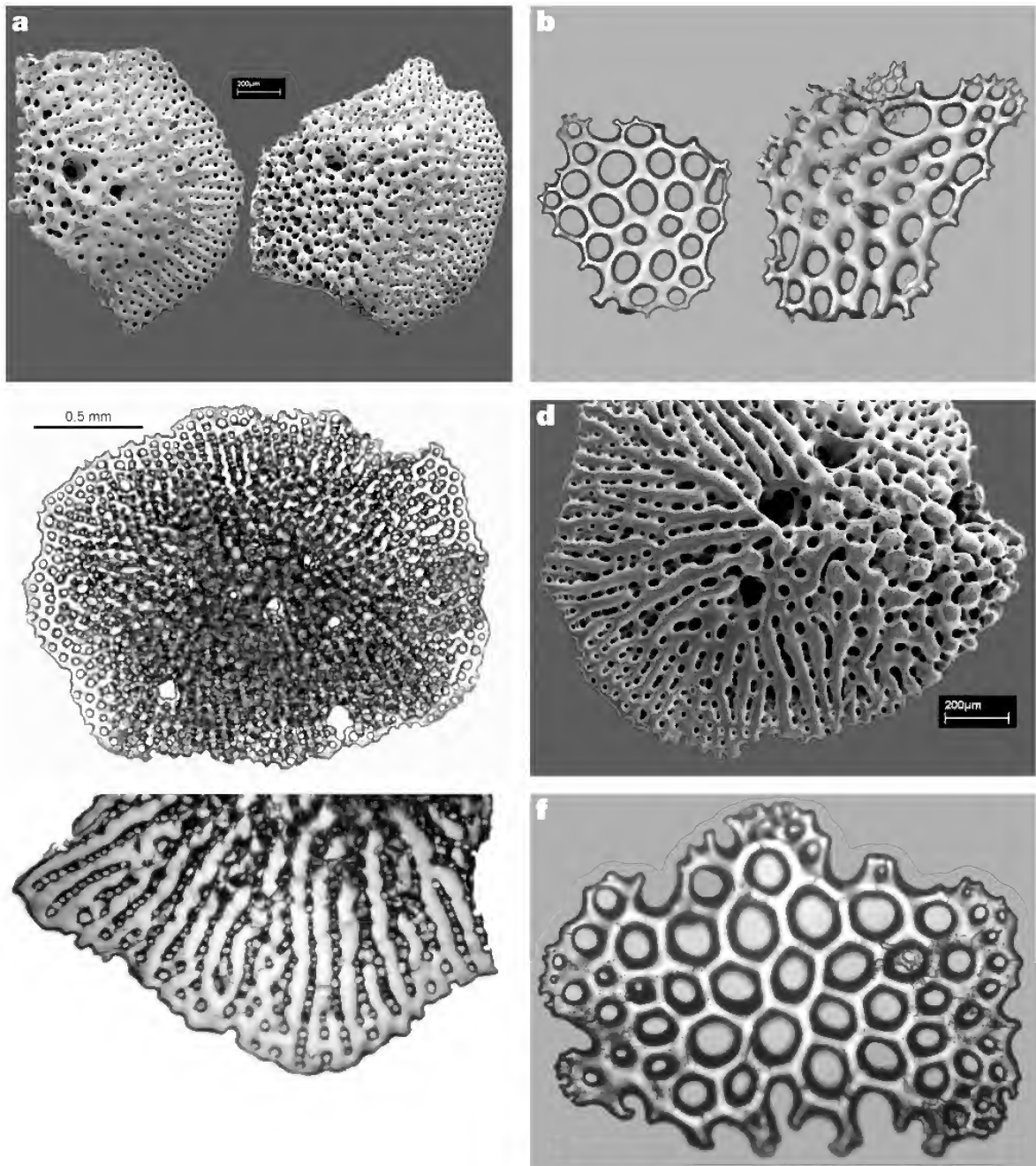


Figure 7. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a, d, SEM by Cynthia Ahearn; b, e, f, by Cynthia Ahearn; c, by Chris Rowley). a, b, *P. pawsoni* sp. nov., paratype USNM E40798: a, dorsal scales; b, tentacle ossicles, larger 520 μm long. c–f, *P. poriferum* (Studer, 1876): c, dorsal scale, holotype ZMB 2259; d, dorsal scale, SAM K2344; e, dorsal scale, SAM K2344; f, tentacle ossicle, 640 μm long, SAM K2344.

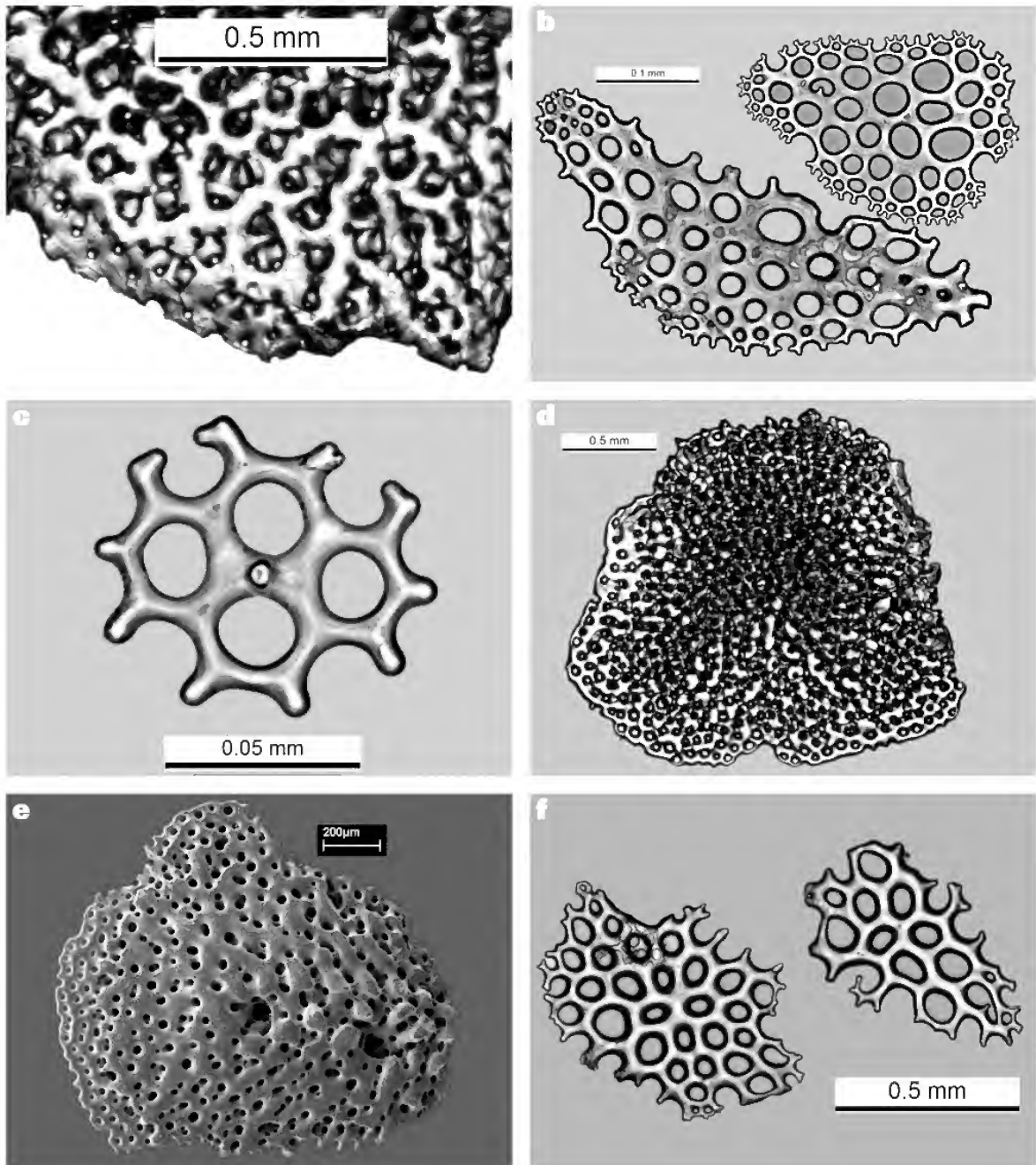


Figure 8. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a–d, f, by Chris Rowley; e, SEM by Cynthia Ahearn): a–c, *P. schnabelae* sp. nov.: a, dorsal scale, holotype SAM K2345; b, tentacle ossicles, holotype SAM K2345; c, plate from sole, paratype, SAM K2346. d–f, *P. whittakeri* sp. nov.: d, dorsal scale, NMV F104834; e, dorsal scale, paratype USNM E40795; f, tentacle ossicles, NMV F104834.

Tentacles: largest tentacle trunk ossicles predominantly smooth perforated plates, irregularly oval, large central perforations grading to numerous small close ones near margin, finely denticulate margin, plates up to 520 μm long; some thicker plates with large perforations, plates up to 300 μm long; few rod-plates, up to 300 μm long.

Colour (preserved). Body pale brown to off-white; scales haloed, with pale outer edge (single-layer perforated edge of scales with white thickening).

Distribution. Eastern Antarctica, MacRobertson Land, slope off Prydz Bay; 1266 m.

Etymology. Named for Kareen Schnabel (NIWA), with gratitude for her generous and gracious assistance with loan material and data from NIWA.

Remarks. The original Banzare lot from station 29 comprises three specimens. We are not confident that the two smaller specimens are conspecific with the holotype, and they are assigned to "Other material" with reservation. We note that this species is recorded for a significantly greater depth than the other species of the *Psolidium poriferum* group. *Psolidium schnabelae* sp. nov. is distinguished diagnostically by the predominant form of the largest tentacle ossicles with large central perforations grading to small peripheral ones.

Psolidium tenue Mortensen

Figures 3e, f; 6c-f

Psolidium tenue Mortensen, 1925: 8–9, text figs 4–5.

Psolidium incertum.—O'Loughlin et al., 1994: 552, 554 (non *Psolidium incertum* (Théel, 1886) = *Psolidium poriferum* (Studer, 1876)).

Material examined. Antarctic Peninsula, 90 m, USNM E40789 (1 specimen); 265 m, E40790 (1); 100–200 m, E40791 (2); 270 m, E40792 (6); 330 m, E40793 (2); 212 m, E40794 (1); 311 m, E40796 (1); 325 m, E40801 (1); 670 m, USNM 1005859 (2); *Discovery* stns 181, Palmer Archipelago, 160–335 m, BM(NH) 2008.3191 (1); 182, 278–500 m, BM(NH) 2008.3192 (1); 187, 0–195 m, BM(NH) 2008.3193 (1); 190, 0–250 m, BM(NH) 2008.3194–3196 (3); 599, W of Adelaide I., 0–150 m, BM(NH) 2008.3197–3198 (2).

Ross Sea, 923 m, USNM E40776 (1); NIWA *Tangaroa* 0802, 67–74°S 167°E–179°W, 420–866 m, NIWA 36003 (1); 36027 (20); 38102 (1); 38545 (1); 38815 (4); 38842 (1); 38872 (1); 38884 (18); 38956 (9); 45698 (3); 45727 (2); 45728 (1); *Discovery* stns 1644, 626 m, BM(NH) 2008.3199 (1); 1649, 695 m, BM(NH) 2008.3200–3201 (2); 1652, 0–500 m, BM(NH) 2008.3202–3205 (4); 1660, 0–351 m, BM(NH) 2008.3206–3208 (3); 2200, Balleny Is, 512–532 m, BM(NH) 2008.3209–3218 (11); NZOI *Endeavour* stns A461, 0–550 m, NIWA 43870 (many specimens); A466, 555 m, NIWA 43871 (many); A521, 569 m, NIWA 43872 (5); A531B, 348 m, NIWA 44705 (1); A537, 546 m, NIWA 43873 (4); D216, 463 m, NIWA 43874 (4); E199, 278 m, NIWA 43875 (2); E200, 646 m, NIWA 43876 (1); E203, 187 m, NIWA 43877 (4); E220A, 371 m, NIWA 43883 (many); E220B, 371 m, NIWA 43878 (many); E212B, 91 m, NIWA 43879 (1).

Wilkes Land, 183 m, USNM E40799 (1); Banzare stn 97, 474 m, SAM K2347 (1).

Prydz Bay, 320–768 m, NMV F68113 (2); F68116 (1); F68117 (2); F107415 (1); F107416 (1); F105417 (1); F107437 (1); F107438 (1); F107442 (1); F107443 (1); F107447 (1); SAM K2219 (1); Banzare stn 103, SAM K2348 (4).

New Zealand, Antipodes I., 2100 m, USNM 1004885 (1).

Diagnosis. *Psolidium* species up to 50 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 3.0 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, reticulate thickenings from near margin towards centre, multi-layered centrally; rarely any development of smooth white thickening with smaller perforations; rarely any development of radiating-to-margin thickenings; up to 3 tube foot canals per plate; rare tube foot support plates; endplates small, mesh-like.

Sole ossicles: throughout most of sole rare, small, smooth, thin, irregularly shaped perforated plates, 0–8 large perforations, up to 230 μm long; sometimes as regular 4-holed plates with slightly knobbed margin, sometimes with surface knobs, plates 100–200 μm long; near margin of sole and peripheral tube feet some thicker irregular perforated rod-plates, up to 570 μm long, intergrading with irregularly oval thick perforated plates, with secondary layering, up to 480 μm long.

Tentacles: largest tentacle trunk ossicles predominantly long, narrow, thick, rod-plates (rods joined to create perforations) and perforated plates with prominent rod thickenings; not predominantly smooth perforated plates; rod-plates variably straight or bent or curved, up to 800 μm long.

Colour (preserved). Body variably dark brown to pale brown to off-white; coarse red-brown flecking dorso-laterally; scales with a light-coloured "haloed" marginal appearance.

Distribution. Antarctic Peninsula, Ross Sea, Wilkes Land, Prydz Bay, 90–923 m; New Zealand, Antipodes I., 2100–2100 m.

Remarks. We raise *Psolidium tenue* Mortensen, 1925, out of a synonymy by Gutt (1988) with *Psolidium incertum* (Théel, 1886), synonymised above with *Psolidium poriferum* (Studer, 1876). *P. poriferum* is an almost exclusively Sub-Antarctic species. The single type specimen for *Psolidium tenue* Mortensen, 1925, was taken north of Discovery Inlet in the Ross Sea from 640 m. There are no inconsistencies between the original description and the material studied here from the Ross Sea. The length (preserved length of 30 mm), paucity of ossicles in the sole, single small knob sometimes present on the ossicles in the sole, and size of ossicles in the sole are all consistent with the Ross Sea material. *Psolidium tenue* Mortensen, 1925, is distinguished diagnostically by the rod-plate form of the largest tentacle ossicles.

Psolidium whittakeri sp. nov.

Figures 3b-d; 8d-f

Psolidium incertum.—Ludwig and Heding, 1935: 162–64, text figs 28–29 (non *Psolidium incertum* (Théel, 1886) = *P. poriferum* (Studer, 1876) (above)).

Material examined. Holotype: Scotia Sea, South Sandwich Is, Saunders I., 57°39'24"S 26°26'42"W, 415–613 m, R/V *Islas Orcadas*, USARP cr 575 stn 52, 26 May 1975, USNM 1112365.

Paratypes: type locality and date, USNM E40795 (39 specimens); NMV F157431 (6).

Other material: South Sandwich Is, 146–527 m, USNM E40817 (1); 355–468 m, E40818 (1); 302–375 m, E40819 (2); 360–486 m, E40827 (2); 452–759 m, E40828 (1).

Bouvet I., *Icefish* 2004 stn 59, 408–656 m, NMV F104857 (3); stn 71, 193–207 m, F104867 (1); stn 73, 316 m, F104896 (1); stn 76, 650–646 m, F104837 (7).

South Shetland Is., Elephant I., 326–382 m, AMLR-03 stn 38, NMV F104849 (1); Deception I., 460–484 m, AMLR-03 stn 88, F104834 (3); F104835 (1).

Diagnosis. *Psolidium* species up to 42 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 2.0 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, multi-layered centrally; reticulate thickenings extend from near margin towards centre of plate, thickenings near margin sometimes parallel to edge of plate, sometimes coalesce into smooth thickenings with smaller perforations, lacking frequent radiating linear thickenings between marginal perforations; up to 4 tube foot canals or marginal indentations per plate; dorsal and lateral tube feet lack support ossicles.

Sole ossicles: throughout sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, 0–9 large perforations, bluntly spined around margin, sometimes surface knobs, up to 260 μ m long; sometimes as regular 4-holed plates with bluntly spined margin, sometimes surface knobs, up to 230 μ m long; near margin of sole and peripheral tube feet thicker irregular rods and elongate perforated rod-plates, up to 420 μ m long, intergrading with some round to oval, perforated thick plates up to 350 μ m long, some with secondary layering.

Tentacles: largest tentacle trunk ossicles; perforated plates, irregularly round to oval to elongate to narrow, thick, smooth, lacking rod-like thickenings between perforations; perforations large, irregular in size, rare incipient secondary developments; plates up to 750 μ m long; rare rod-plates, up to 440 μ m long.

Colour (preserved). Dorsal and lateral body off-white (type material) to pale brown to brown (Bouvet and South Shetland Is material); scales faintly haloed, with pale outer edge (single-layer perforated edge of scales with white thickening); small dark brown markings; sole off-white to pale brown to brown.

Distribution. South Sandwich Is, South Shetland Is, Bouvet I.; 146–759 m.

Etymology. Named for Scott Whittaker (USNM), with appreciation and gratitude for his generous and gracious assistance to Cynthia Ahearn in preparing SEM images.

Remarks. We judge that the 10 specimens from Bouvet I. (567 m) that were referred to *Psolidium incertum* (Théel, 1886) (= *P.*

poriferum above) by Ludwig and Heding (1935) do not differ in any diagnostic characters from material from Bouvet I. examined here, and hence from *Psolidium whittakeri* sp. nov. In particular, the smooth perforated plate form of the tentacle trunk ossicles and the pale brown body and brown sole are the same. The preserved colour of the type material of *Psolidium whittakeri* sp. nov. (collected in 1975) is off-white. The recent material from Bouvet and the South Shetland Islands (collected in 2003 and 2004) is brown. It is difficult to judge whether this significant colour difference is due to preservation history or species difference. No significant morphological differences have been detected and it remains for current work on molecular genetic evidence to confirm species status. Of the series of *poriferum*-like species of *Psolidium*, we recognise that *P. whittakeri* sp. nov. (Bouvet, South Sandwich, South Shetland Is) is closest to *P. pawsoni* sp. nov. (Weddell Sea), but judge that there is significantly more frequent development of smooth white thickening on the scales of *P. pawsoni*. We note also that the *P. whittakeri* specimens are significantly larger (up to 42 mm long) than the *P. pawsoni* specimens that were available (up to 28 mm long).

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References

- Arnaud, P.M. 1974. Contribution à la bionomie marine benthique des régions antarctiques et subantarctiques. *Téthys* 6(3): 465–656.
- Bell, J.F. 1882. Studies in the Holothuroidea. I. On the genus *Psolus* and the forms allied thereto. *Proceedings of the Zoological Society, London*. 1882: 641–50, pl. 48.
- Branch, M. L., Jangoux, M., Alvá, V., Massin, C. and Stapanato, S. 1993. The Echinodermata of subantarctic Marion and Prince Edward Islands. *South African Journal of Antarctic Research* 23(1, 2): 37–70.
- Cherbonnier, G. 1974. Invertébrés marins des XIIème et XVème expéditions antarctiques Françaises en Terre Adélie. 15. Holothurides. *Téthys* 5(4): 601–10.

- Deichmann, E. 1941. The Holothurioidea collected by the *Velero III* during the years 1932–1938. I. Dendrochirotida. *Allan Hancock Pacific Expeditions* 8(3): 61–194, pls 10–30.
- Deichmann, E. 1947. Shallow water holothurians from Carbo de Hornos and adjacent waters. *Anales del Museo Argentino de Ciencias Naturales. Invertebrados Marinos* 8: 325–51.
- Ekman, S. 1925. Holothurien. *Further zoological results of the Swedish Antarctic Expedition 1901–1903* 1(6): 1–194.
- Ekman, S. 1927. Holothurien der deutschen Südpolar-Expedition 1901–1903 aus der Ostantarktis und von den Kerguelen. *Deutsche Südpolar-Expedition* 19 (Zoology 11): 359–419.
- Forbes, E. 1841. *A history of British starfishes and other animals of the class Echinodermata*. John van Voorst: London. 267 pp.
- Grieg, J.A. 1929a. Echinodermata from the Palmer Archipelago, South Shetlands, South Georgia and the Bouvet Island. *Scientific Results of the Norwegian Antarctic Expeditions 1927–1928 and 1928–1929*, 1(2): 1–16.
- Grieg, J.A. 1929b. Some echinoderms from the South Shetlands. *Bergens Museum Årbok 1929. Naturvidenskapelig rekke* 3: 1–10.
- Grube, A.E. 1840. *Aktinien, Echinodermen und Würmer des Adriatischen und Mittelmeeres*. J. H. Bon: Königsberg. 92 pp.
- Guille, A. 1982. A new genus and species of ophiacanthid brittlestar (Echinodermata: Ophiuroidea) from the Kerguelen Islands, with new taxonomic, biogeographic and quantitative data on the echinoderm fauna. *Australian Museum Memoir* 16: 67–87.
- Gutt, J. 1988. Zur Verbreitung und Ökologie der Seegurken (Holothuroidea, Echinodermata) im Weddellmeer (Antarktis). *Berichte zur Polarforschung* 41: 1–87.
- Gutt, J. 1991a. On the distribution and ecology of holothurians in the Weddell Sea (Antarctica). *Polar Biology* 11: 145–55. Gutt, J. 1991b. Are Weddell Sea holothurians typical representatives of the Antarctic benthos? *Meeresforschung* 33(4): 312–29.
- Hickman, V.V. 1962. Tasmanian sea-cucumbers (Holothuroidea). *Papers and Proceedings of the Royal Society of Tasmania* 96: 49–72, 2 pls, 186 figs.
- Lambert, P. 1996. *Psolidium bidiscum*, a new shallow-water psolid sea cucumber (Echinodermata: Holothuroidea) from the northeastern Pacific, previously misidentified as *Psolidium bullatum* Ohshima. *Canadian Journal of Zoology* 74: 20–31.
- Lampert, K. 1885. Die Seewalzen. Holothuroidea. Eine Systematische Monographie. 310 pp, 1 pl. in C. Semper (ed.) *Reisen im Archipel der Philippinen* 2(4)3: 1–310, 1 pl.
- Lampert, K. 1889. Die während der expedition SMS *Gazelle* 1874–1876 von Prof. Dr. Th. Studer gesammelten holothurien. *Zoologische Jahrbücher. Abtheilung für Systematik, Geographie und Biologie der Thiere* 4(4): 806–58, pl. 24.
- Ludwig, H. 1886. Die von G. Chierchia auf der Fahrt der Kgl. Italienische Corvette *Vettor Pisani* gesammelten Holothurien. *Zoologische Jahrbücher* 2: 1–36, 2 pls.
- Ludwig, H. 1892. Echinodermen. Pp. 325–61, pls 15–17 in: Dr H.G. Bronn's *Klassen und Ordnungen des Thier-Reichs* 2(3) 3 Das System. C. F. Winter'sche Verlagshandlung: Leipzig and Heidelberg. 460 pp, 17 pls.
- Ludwig, H. 1894. Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the US Fish Commission steamer *Albatross*, during 1891. XII. The Holothuroidea. *Memoirs of the Museum of Comparative Zoology, Harvard University* 17(3): 1–183, pls 1–19.
- Ludwig, H. 1898. Holothurien. *Ergebnisse der Hamburger Magalhaensischen Sammelreise 1892/93* 1: 1–98, 3 pls.
- Ludwig, H. & Heding, S.G. 1935. Die holothurien der Deutschen Tiefsee-Expedition. 1. Fusslose und dendrochirote formen. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem dampfer Valdivia 1898–1899* 24: 123–214.
- Massin, C. 1992. Holothurians (Echinodermata) from Marion and Prince Edward Islands: new and little-known species. *Zoologica Scripta* 21(3): 311–24.
- Mortensen, T. 1925. On a small collection of echinoderms from the Antarctic Sea. *Arkiv för zoologi* 17A(31): 1–12, 8 figs.
- Mortensen, T. 1927. *Handbook of the Echinoderms of the British Isles*. Oxford University Press. London. 471 pp.
- O'Loughlin, P.M. 2002. Report on selected species of BANZARE and ANARE Holothuroidea, with reviews of *Meseres* Ludwig and *Heterocucumis* Panning (Echinodermata). *Memoirs of Museum Victoria* 59(2): 297–325.
- O'Loughlin, P.M. and Ahearn, C. 2005. A review of pygal-furrowed Synallactidae (Echinodermata: Holothuroidea), with new species from the Antarctic, Atlantic and Pacific oceans. *Memoirs of Museum Victoria* 62(2): 147–79.
- O'Loughlin, P.M., Bardsley, T.M. and O'Hara, T.D. 1994. A preliminary analysis of diversity and distribution of Holothuroidea from Prydz Bay and the MacRobertson Shelf, Eastern Antarctica. Pp. 549–55, 1 fig., 2 tpls in: David, B., Guille, A., Féral, J.-P. and Roux, M. (eds), *Echinoderms through Time. Proceedings of the Eighth International Echinoderm Conference, Dijon, France, 6–10 September, 1993*. Balkema, Rotterdam.
- O'Loughlin P.M. and Maric, D. 2008. Australian species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae). *Memoirs of Museum Victoria* 65: 1–22.
- Pawson, D.L. 1969. Holothuroidea. Pp. 36–38, 1 pl. in: V.C. Bushnell and J.W. Hedgpeth (eds), *Distribution of Selected Groups of Marine Invertebrates in Waters South of 35°S Latitude. Antarctic Map Folio Series (II)*. American Geographical Society, New York.
- Pawson, D.L. 1971. The Western Australian psolid holothurian *Cetocuvieria* (Cuvier). *Journal of the Royal Society of Western Australia* 54(2): 33–39.
- Pawson, D.L. 1982. Holothuroidea. Pp. 813–18; figs pp. 791–92; pls 136, 137 in: S.P. Parker (editor-in-chief), *Synopsis and Classification of Living Organisms*. McGraw-Hill, New York.
- Pawson, D.L. and Fell, H.B. 1965. A revised classification of the dendrochirote holothurians. *Breviora* 214: 1–7.
- Pawson, D.L. and Valentine, J.F. 1981. *Psolidium prostratum*, new species, from off the east coast of the USA (Echinodermata: Holothuroidea). *Proceedings of the Biological Society of Washington* 94(2): 450–54.
- Perrier, R. 1902. Holothuries. Pp. 273–554, pls 12–22 in: *Expéditions scientifiques du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883*. Masson et Cie, Éditeurs, Paris.
- Perrier, M. R. 1904. Holothuries du cap Horn. *Bulletin du Muséum d'Histoire Naturelle* 1: 13–17.
- Perrier, R. 1905. Holothuries antarctiques du Muséum d'Histoire Naturelle de Paris. *Annales des Sciences Naturelles. Zoologie* 1: 1–146, 5 pls.
- Studer, T. 1876. Über Echinodermen aus dem antarktischen Meere und zwei neue Seeigel von den Papua-Inseln, gesammelt auf der Reise SMS *Gazelle* um die Erde. *Monatsberichte der Königlich Preussischen Akademie der Wissenschaften*. Berlin. Pp. 452–65.
- Studer, T. 1879. Die fauna von Kerguelensland. *Archiv für Naturgeschichte* 45(1): 104–41.
- Studer, T. 1889. *Die Forschungsreise SMS Gazelle in den Jahren 1874 bis 1876. 3. Zoologie und Geologie*. Foreword + 322 pp., 33 pls. Mittler und Son, Berlin.
- Thandar, A.S. 1999. Deep-sea holothuroids taken by the RV *Africana II* in 1959, from off the west coast of the Cape Peninsula, South Africa. *Annals of the South Africa Museum* 105: 364–409.

- Thandar, A.S. 2006. New species and new records of dendrochirotid and dactylochirotid holothuroids (Echinodermata: Holothuroidea) from the east coast of South Africa. *Zootaxa* 1245: 1–51.
- Théel, H. 1886. Report on the Holothurioidea dredged by HMS *Challenger* during the years 1873–1876. *Report on the scientific results of the voyage of HMS Challenger*, *Zoology* 14(39): 1–290, 16 pls.
- Vaney, C. 1908. Les holothuries de l'Expédition Antarctique Nationale Écossaise. *Transactions of the Royal Society of Edinburgh* 46: 405–41, 5 pls.
- Vaney, C. 1914. Holothuries. Deuxième Expédition Antarctique Française (1908–10). *Sciences Naturelles: Documents Scientifiques*. Masson et Cie, Éditeurs, Paris. 54 pp., 5 pls.



***Marmenuera*, a new genus of leptophlebiid mayfly (Insecta: Ephemeroptera) endemic to Tasmania.**

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Abstract

Dean, J.C., Forteath G.N.R. and Osborn, A.W. 2008. *Marmenuera*, a new genus of leptophlebiid mayfly (Insecta: Ephemeroptera) endemic to Tasmania. *Memoirs of Museum Victoria* 65: 43–50.

The genus *Marmenuera* gen. nov. is established to accommodate two species of leptophlebiid mayfly, both of which are endemic to Tasmania. Adults and nymphs of *M. ida* (Tillyard) and *M. tillyardi* sp. nov. are described and figured.

Keywords

Mayflies; Australia; taxonomy; *Marmenuera*; *M. tillyardi* sp. nov.; *M. ida* (Tillyard); Leptophlebiidae.

Introduction

The generic taxonomy of leptophlebiid mayflies of Australia, although still incomplete, has been advanced in recent years. A preliminary generic key to nymphs (Dean, 1999) included 15 described and eight undescribed leptophlebiid genera. Of the eight undescribed genera, three have since been described (*Loamaggalangta* Dean et al., 1999, *Kanina* Dean, 2000 and *Mangabora* Dean and Suter, 2004), a fourth is described below and “Genus S” from southwest Australia has previously been referred to *Loamaggalangta* (Dean, 2000).

The present paper erects a new genus to accommodate two species of Leptophlebiidae from Tasmania. The nymphs of these species were designated Genus W sp.AV1 and Genus W sp.AV2 by Dean (1999). Recent biological studies in Lake Pedder and several inflowing streams provided an opportunity to rear out adults of both species. Repositories of type and other material are abbreviated as follows: Museum of Victoria (MV); Australian National Insect Collection, Canberra (ANIC); British Museum of Natural History (BMNH). Abbreviations of life stages of examined material are: N, nymph; MI, male imago; FI, female imago; MS, male subimago; FS, female subimago.

Taxonomy

Order Ephemeroptera, Family Leptophlebiidae, Subfamily Atalophlebiinae

Genus *Marmenuera* gen. nov.

Diagnostic features. *Imago*. Forewing (figs 1, 3, 17, 19): membrane hyaline, cells in apical third of wing translucent white; veins brown, many crossveins suffused with dark brown pigmentation; length-width ratio of forewing slightly less to slightly greater than 3.0; four to seven costal crossveins basal to the bulla, 11–19 distal to the bulla; MA forked at 0.40–0.43 wing length; MP₂ attached by crossvein to MP₁ at 0.18–0.20 wing length; base of ICu₁ linked to both CuA and CuP by a crossvein; ICu₁ and ICu₂ strongly diverging as wing margin approached. Hindwing (figs 2, 4, 18, 20): 0.22–0.26 length of forewing; length/width ratio 1.6–1.9; costal margin with shallow concavity at about midlength, costal space broader both basal and distal to the concavity; vein Sc joining costal margin at 0.8–0.85 wing length; 7–13 costal crossveins and 6–11 subcostal crossveins. Legs: yellow or medium brown, all femora with two strongly developed dark brown bands, one at midlength and the other near the apex; tarsal claws similar, each claw with an apical hook and opposing ventral flange (fig. 9); forelegs of male with ratios of segment lengths 0.81–0.86, 1.00, 0.05–0.07, 0.34–0.35, 0.34–0.38, 0.26–0.30, 0.11–0.23. Male genitalia (figs 7, 8, 24, 25): claspers three-segmented, basal segment narrowing abruptly at about midlength; penes lobes fused in basal half, widely separated apically; each lobe relatively broad and approximately parallel-sided, with three moderate sized ventral spines close to inner margin and slightly posterior to where the lobes separate (fig. 8). Female

sternum nine with apical margin deeply excised (Fig. 10). *Subimago*. Wings pale fawn/white, brown blotches and/or suffusions similar in distribution and intensity to corresponding imago. *Mature nymph*. Head prognathous; antennae at least half length of body. Mouthparts: clypeus with lateral margins sub-parallel; labrum (figs 12, 27) slightly wider than clypeus, width 1.7–1.9 times length along median line, anterior margin with shallow to moderate mesal concavity, frontal setae arranged as single row, sub-apical setae arranged in a single row set back from anterior margin at about 0.9x labrum length; mandibles with outer margin somewhat angular at midlength, gently curved basally and distally, a tuft of long setae around midlength and a sparser series of long setae basal to the tuft, incisors slender, prostheca strongly developed; maxillae quadrate, subapical row of 30–35 pectinate setae, palp moderately short, three segmented, terminal segment almost as long as middle segment, middle segment bearing simple setae only; labium with glossae elongate, turned under ventrally, palp three-segmented, terminal segment almost as long as middle segment and with series of small spine-like setae along inner margin, submentum with fringe of long setae along lateral margins. Legs banded; femora moderately broad (figs 13, 28); tarsal claws smooth, without ventral teeth (figs 14, 29). Abdominal segments without setae on lateral margins, postero-lateral spines on segments 7–9; posterior margins of abdominal terga with series of long, robust spines interspersed with minute spines (fig. 15). Gills present on abdominal segments 1–7; each gill lanceolate, lateral tracheae strongly developed (fig. 16). Caudal filaments about $1\frac{1}{2}$ times length of body; each segment with apical whorl of both stout spine-like setae and fine hair-like setae, spine-like setae predominating near base of each filament but becoming shorter towards midlength where the hair-like setae predominate.

Type species. Marmenuera tillyardi sp.nov.

Etymology. The generic name is derived from “mar.me.nuer”, the western Tasmanian aboriginal word for “country” or “tribal territory” (Plomley 1976, p.191), and pertains to the endemicity of the genus to Tasmania.

Remarks. The genus *Marmenuera* can be distinguished from all other leptophlebiid genera by the following combination of characters. Imago: (1) basal half of forewing with costal crossveins heavily suffused with dark brown, often with brown pigmentation more extensive; (2) forewing with ICu_1 attached to CuA and CuP by crossveins; (3) ICu_1 and ICu_2 strongly diverging as wing margin approached; (4) hindwing with shallow concavity at about midlength, and Sc joining wing margin at 0.8–0.85 wing length; (5) tarsal claws similar; (6) male genitalia with penes fused in basal half and widely separated apically, with three moderate-sized ventral spines situated slightly posterior to where the lobes separate; (7) female sternum nine with apical margin deeply excised. Nymph: (1) labrum slightly wider than clypeus; (2) width of labrum 1.7–1.9 times length along median line; (3) labium with glossae elongate and turned under ventrally; (4) terminal segment of labial palp with series of small spine-like setae along inner margin; (5) submentum with fringe of long setae

along lateral margins; (6) tarsal claws smooth; (7) gills lanceolate, moderately broad; (8) posterior margins of abdominal terga with row of stout spines interspersed with small spines.

Marmenuera does not fit into any of the leptophlebiid lineages defined by Pescador and Peters (1980), and Towns and Peters (1980), and its closest relatives are probably here in Australia. The genus appears most closely related to *Loamaggalangta* Dean, Forteath and Osborn and *Bibulmena* Dean. The three genera share many characters, including attachment of the base of ICu_1 to the CuA – CuP crossvein in the forewing, similar tarsal claws in the imago, a deeply excised sternum nine in the female, similarities in the nymphal mouthparts (in particular the elongate and underturned glossae, the fringe of setae on the lateral margins of the submentum and the small spine-like setae along the inner margin of segment 3 of the labial palps) and smooth tarsal claws in the nymph. Christidis (2005) placed *Bibulmena* and *Loamaggalangta* at the base of a large clade containing many of the Australian leptophlebiid genera, but found no support for the grouping of these two genera into a monophyletic clade. The character states listed above are perhaps primitive and not synapomorphies.

Marmenuera tillyardi sp.nov.

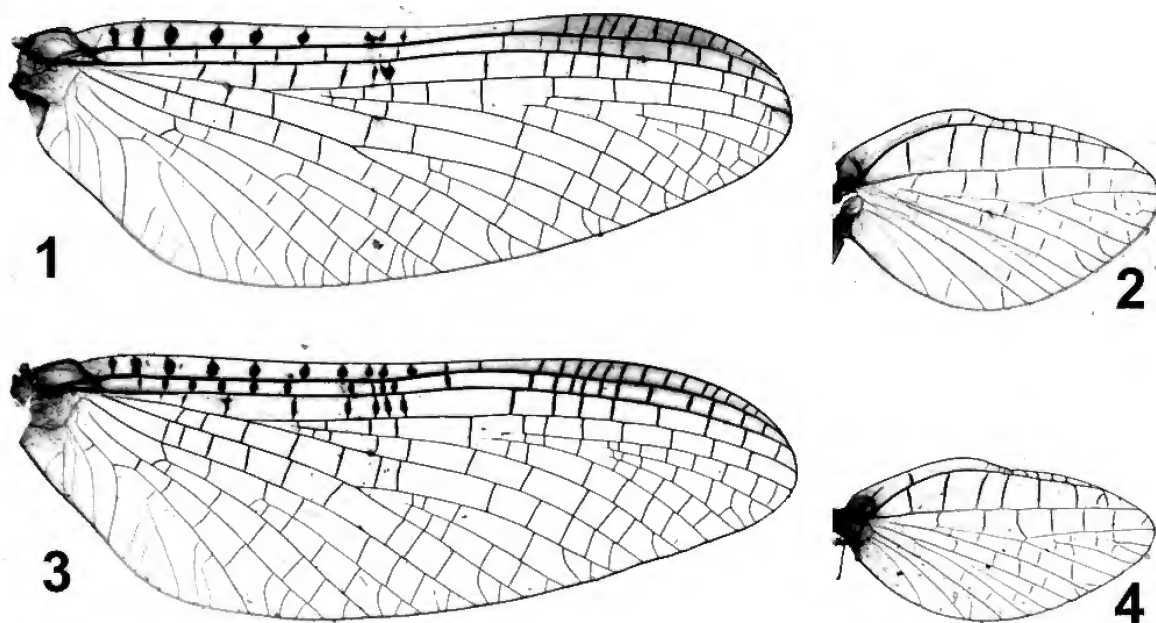
Figures 1–16

Genus W sp.AV1 Dean 1999, p. 86, figs 239–41.

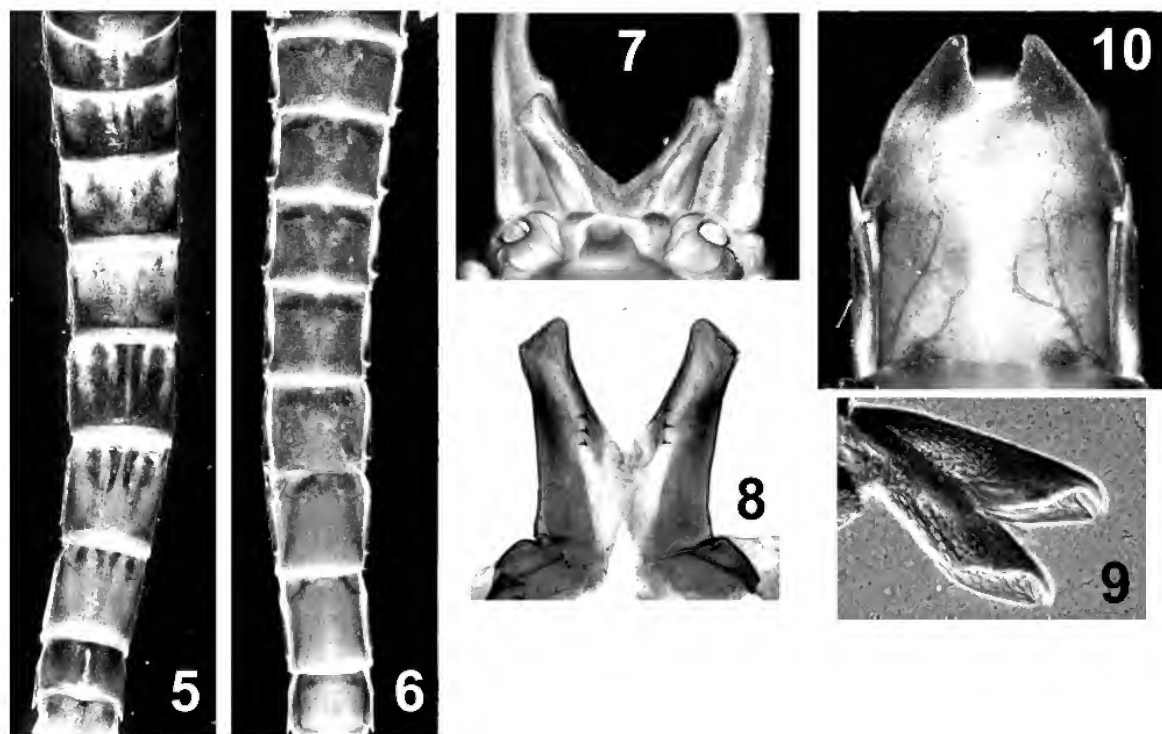
Types. Holotype: Male imago (reared from nymph), Tasmania, unnamed creek flowing into Lake Pedder (Tasmap 1:25 000 series, Serpentine 4026, Grid reference 55G 4184 52606), collected 28 Jan 2006, emerged 30 Jan 2006, A. Osborn and N. Forteath (MV, T-20000). Paratypes: Male imago and female imago (both reared from nymph), same location as holotype, collected 28 Jan 2006, emerged 19 Mar 2006 and 23 Feb 2006 respectively, A.Osborn & N.Forteath (MV, T-20001 and T-20002 respectively); male imago and female imago (both reared from nymph), same location as holotype, collected 5 Jan 2006 and 28 Jan 2006 respectively, emerged 14 Jan 2006 and 13 Feb 2006 respectively, A.Osborn and N.Forteath (ANIC).

Material examined. Tasmania. 6 MI, 12 FI (all reared from nymphs), un-named creek flowing into Lake Pedder (type locality), 28 Jan 2006, emerged various dates, A. Osborn and N. Forteath; 3 MI, 1 FI (all reared from nymphs), same location, 25 Jan 1998, N. Forteath; 1 FI (reared from nymph), same location, 23 Feb 1998, N. Forteath; 1 MI, 1 FI (both reared from nymphs), same location, 4 Mar 1998, N. Forteath; 2 MI, 2 FI (all reared from nymphs), same location, 5 Jan 2006, A. Osborn and N. Forteath; 1 MS, 1 FS (both reared from nymphs), 4 N, same location, 27 Dec 1997, N.Forteath; 2 N, Piney Creek, Heamskirk Rd, 27 Oct 1994, MRHI; 1 FI, 1 FS (both reared from nymphs), Lake Pedder, Trappes Bay, 4 Mar 1998, N. Forteath; 1 MI, 2FI (all reared from nymphs), Lake Pedder, Serpentine Arm, Apr 2005, N.Forteath.

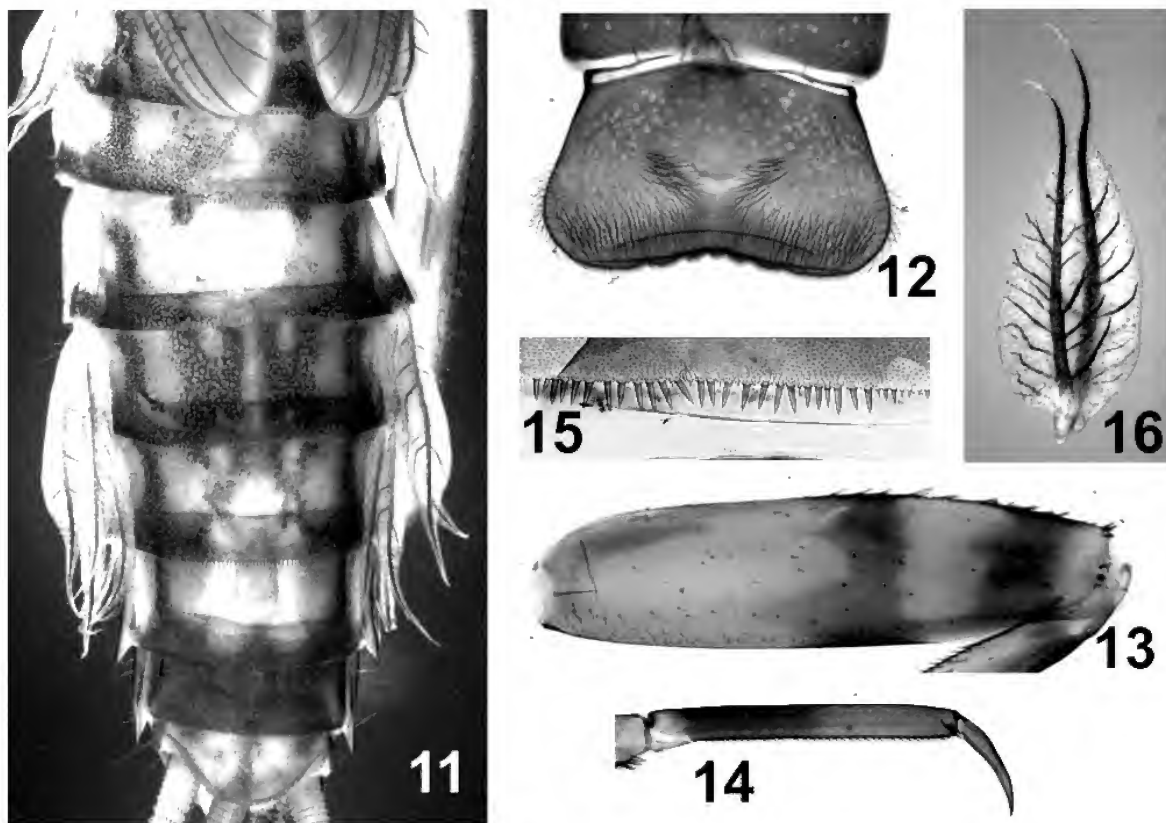
Description. *Male imago*: Length: body 8.8–10.2 mm., forewing 8.8–10.1 mm., caudal filaments 12.4–14.2 mm. Eyes: upper lobes pale pink/brown, separated mesally by a distance approximately $\frac{1}{8}$ of the diameter of the upper lobe in dorsal view; lower lobes grey. Thorax: medium-dark brown; pronotum with narrow raised carina along median line, dark brown markings medially on posterior half of segment, dark brown



Figures 1–4. *Marmenuera tillyardi*. Male imago: 1, forewing; 2, hind wing. Female imago: 3, forewing; 4, hind wing.



Figures 5–10. *Marmenuera tillyardi*. Male imago: 5, abdomen, dorsal; 6, abdomen, ventral; 7, penes, dorsal; 8, penes, ventral, slide preparation; 9, foretarsal claw. Female imago: 10, sternum nine.



Figures 11–16. *Marmenuera tillyardi*. Nymph: 11, abdomen, dorsal; 12, labrum; 13, forefemur; 14, foretarsus; 15, posterior margin of abdominal segment four; 16, gill, abdominal segment four.

along lateral margins and curved dark brown band parallel to lateral margin approximately midway between margin and medial carina. Legs: predominantly medium brown, tending to paler in apical half of tibiae and tarsi; all femora with two broad dark brown bands, one just beyond midlength and the other sub-apical; tarsal claws similar, each claw with terminal sclerotised hook and opposing ventral process. Forewing (fig. 1): membrane hyaline, stigmatic region opaque, white; costal crossveins in basal half of wing heavily suffused with dark brown, subcostal and R_1 – R_2 crossveins in basal half of wing less strongly suffused with dark brown, crossveins near MA fork not suffused with brown. Abdomen: terga generally reddish-brown with dark brown markings, tergum 6 with four conspicuous dark brown longitudinal bands extending over most of the segment (fig. 5), segment 7 with similar bands but restricted to anterior half of the segment, segment 8 with dark markings only adjacent to the anterior margin; sterna reddish brown, inconspicuous paler markings on segments 2–5 (fig. 6), darker brown markings poorly defined. Genitalia (figs 7, 8): penes lobes fused basally, widely separated apically; each lobe

relatively broad and approximately parallel-sided, apically truncate, outer margin somewhat angular just before apex; three moderate sized ventral spines close to inner margin posterior to where the lobes separate.

Female imago. Length: body 10.1–12.2 mm; forewing 10.0–11.8 mm; caudal filaments 13.4–16.4 mm. General colour similar to male imago. Forewing: membrane slightly opaque; costal, subcostal and R_1 – R_2 crossveins all surrounded by suffusion of dark brown, more strongly developed than in male. Abdomen: medium reddish-brown, terga with darker brown markings, sterna medium reddish-brown, no strong markings; sternum nine deeply cleft (fig. 10). **Subimago.** Wings pale fawn/yellow, brown blotches and/or suffusions similar in distribution and intensity to corresponding imago. **Mature nymph.** Body length ranging from about 10 to 13 mm.; antennae about half length of body; cerci about $1\frac{1}{2}$ times length of body, terminal filament a little longer. General colour yellow with dark brown markings; abdomen with conspicuous pattern of dark brown and yellow, abdominal segments 6 and 9 darker than remaining segments (fig. 11); all legs with dark

banding. Mouthparts: labrum (fig. 12) a little broader than clypeus; maximum width 1.7–1.9 times length along median line; maximum width at about 3/4 labrum length, basal to this the lateral margins relatively straight and diverging; anterior margin shallowly concave, with five well developed medial denticles; single row of setae close to frontal edge of labrum, sub-apical setal fringe also consisting of a single row set back from anterior margin at about 0.9 labrum length. Legs relatively slender; forefemora length $3\frac{1}{2}$ –4 times width (Fig. 13), outer margin with moderate number of short, spine-like setae and also longer, hair-like setae; foretarsus (fig. 14) with 30–40 ventral spines; tarsal claws smooth, without ventral teeth. Postero-lateral spines on abdominal segments 7 (small) and 8–9 (relatively large); posterior margins of abdominal terga with series of large, conspicuous spines interspersed with the occasional shorter spine (fig. 15). Gills lanceolate, lateral tracheae moderately developed (fig. 16).

Etymology: The species is named for R.J. Tillyard, who first recognised that this was probably an undescribed species (see below).

Remarks. When describing *Atalophlebia ida*, Tillyard (1936) referred to specimens from Cradle Mountain which were smaller and less spotted than the type series. It now seems likely that these belong to the species herein described as *M. tillyardi*, and Tillyard's decision not to describe the male imago of *A. ida* based on the Cradle Mountain material has been proven taxonomically astute.

Scholes (1961) recommended that the imago and subimago of *A. ida* should be referred to as the "Large Speckled Spinner" and "Large Speckled Dun" respectively, and we suggest that "Lesser Speckled Spinner" and "Lesser Speckled Dun" are appropriate common names for the imago and subimago of *Marmenuera tillyardi*. This reflects both the smaller size of the new species and the reduced wing pigmentation.

Marmenuera ida (Tillyard)

Figures 17–29

Atalophlebia ida Tillyard, 1936: p. 42, fig. 7, plate I(10).

Massartellopsis ida Scholes, 1961: p. 30, plate 2.

Genus W sp. AV2 Dean, 1999: p. 86, figs 242, 243.

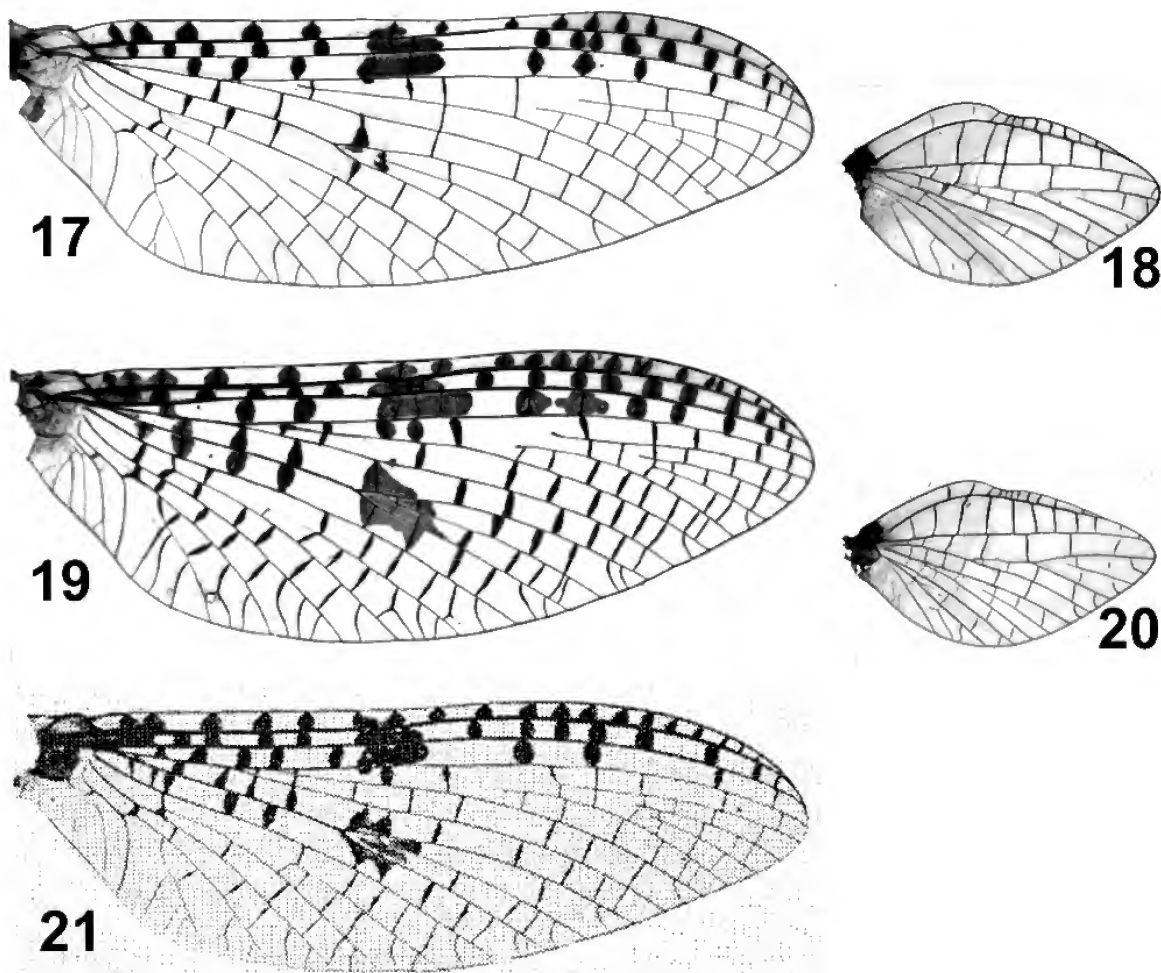
Types. Holotype: female imago, Tasmania, Dee Bridge, 7 Feb 1933, R. J. Tillyard (BMNH). Paratypes: five female imagos, collected with holotype (BMNH); one male subimago, Lake St Clair, 6 Feb 1933, R. J. Tillyard (BMNH). Types not examined.

Material examined. Tasmania. 5N, Lake Pedder, Trappes Inlet, February and April 1997, N. Forteath; 3FI (2 reared), 1FS (reared), same location, 1 Feb 1998, N. Forteath; 1MS (reared), same location, 12 Jan 1998, N. Forteath; 1MS (reared), same location, 4 Mar 1998, N. Forteath; 6MI, 5FI (all reared), 21N, same location, Nov–Dec 2006, N. Forteath and A. Osborn; 1N, Lake Lilla, Cradle Mountain, 25 Mar 1998, J. Dean; 1N, Dip River Falls, 31 Oct 1998, D. Cartwright; 4FI, Huon River Crossing, 16 Feb 1971, A. Neboiss; 1MI, 1MS, 1FS, D'Entrecasteaux Passage, Exit Cave, Jan 1993, A. Clarke.

Description. Male imago. Length: body 11.0–12.4 mm, forewing 11.2–12.0 mm, caudal filaments 18.4–24.2 mm. Eyes: upper lobes pale pink/brown, in contact on meson of head, lower lobes

grey. Thorax: medium-dark brown; pronotum with narrow raised carina along median line, dark brown markings medially on posterior margin, along lateral margins and parallel to lateral margin approximately midway between margin and medial carina. Legs: predominantly yellow, all femora with two broad dark brown bands, one just beyond midlength and the other subapical; tarsal claws similar, each claw with terminal sclerotised hook and opposing ventral process. Forewing (fig. 17): membrane hyaline, stigmatic region slightly opaque, white; all costal, subcostal and R_1 – R_2 crossveins heavily suffused with dark brown, crossveins in vicinity of MA fork also strongly suffused with dark brown; large brown blotch filling area between veins Sc and R_2 at midlength of wing. Abdomen: strongly contrasting pattern of dark brown and yellow; terga 2–7 yellow in anterior half and dark brown in posterior half, yellow colouration extended back as narrow band along median line (fig. 22), extent of yellow colouration increasing from segments 6 to 8, segments 9 and 10 predominantly brown; sterna reddish brown, pale yellow along lateral margins, segments 2–7 with two pairs of small pale spots, the anterior pair more widely separated than the posterior pair (fig. 23). Genitalia (figs 24–25): penes lobes fused basally, widely separated apically; each lobe relatively broad, apex rounded and turned slightly inwards, sub-apically with outer margin evenly curved, three moderate sized ventral spines posterior to where the lobes separate. **Female imago.** Length: body 11.6–14.8 mm.; forewing 12.0–14.2 mm; caudal filaments 18.2–22.2 mm. Forewing: pigmentation more extensive than in male; dark brown suffusions around costal, subcostal and R_1 – R_2 crossveins broad, almost circular; large brown blotch surrounding MA fork. General colour and abdominal markings similar to male imago. **Mature nymph.** Body length ranging from 12–16 mm; antennae a little over half length of body; cerci about $1\frac{1}{4}$ – $1\frac{1}{2}$ body length, terminal filament a little longer. General colour yellow with brown markings; abdomen with conspicuous pattern of dark brown and yellow, segments 2–8 yellow towards anterior margin and dark brown to the posterior (fig. 26); all legs yellow with dark banding. Mouthparts: Labrum (fig. 27) a little broader than clypeus; maximum width 1.7–1.9 times length along median line; maximum width at about 2/3 labrum length, basal to this the lateral margins relatively straight and diverging; anterior margin moderately concave, with five well developed medial denticles. Legs moderately broad (fig. 28); forefemora length a little over 3 times width, outer margin bearing moderate length spine-like setae and also some longer, hair-like setae; fore-tarsus with 15–20 ventral spines (fig. 29); tarsal claws smooth, without ventral teeth. Postero-lateral spines on abdominal segments 7 (small) and 8–9 (relatively large); posterior margins of abdominal terga with series of large, conspicuous spines interspersed with the occasional shorter spine. Gills lanceolate, lateral tracheae moderately developed.

Remarks. Although the holotype has not been examined the description and, in particular, the image of the female forewing presented by Tillyard (1936) leave no doubt as to the identity of this species. The species is readily distinguished from *M. tillyardi* in the adult by the abdominal colour pattern, the more extensive pigmentation of the forewing and the structure of the



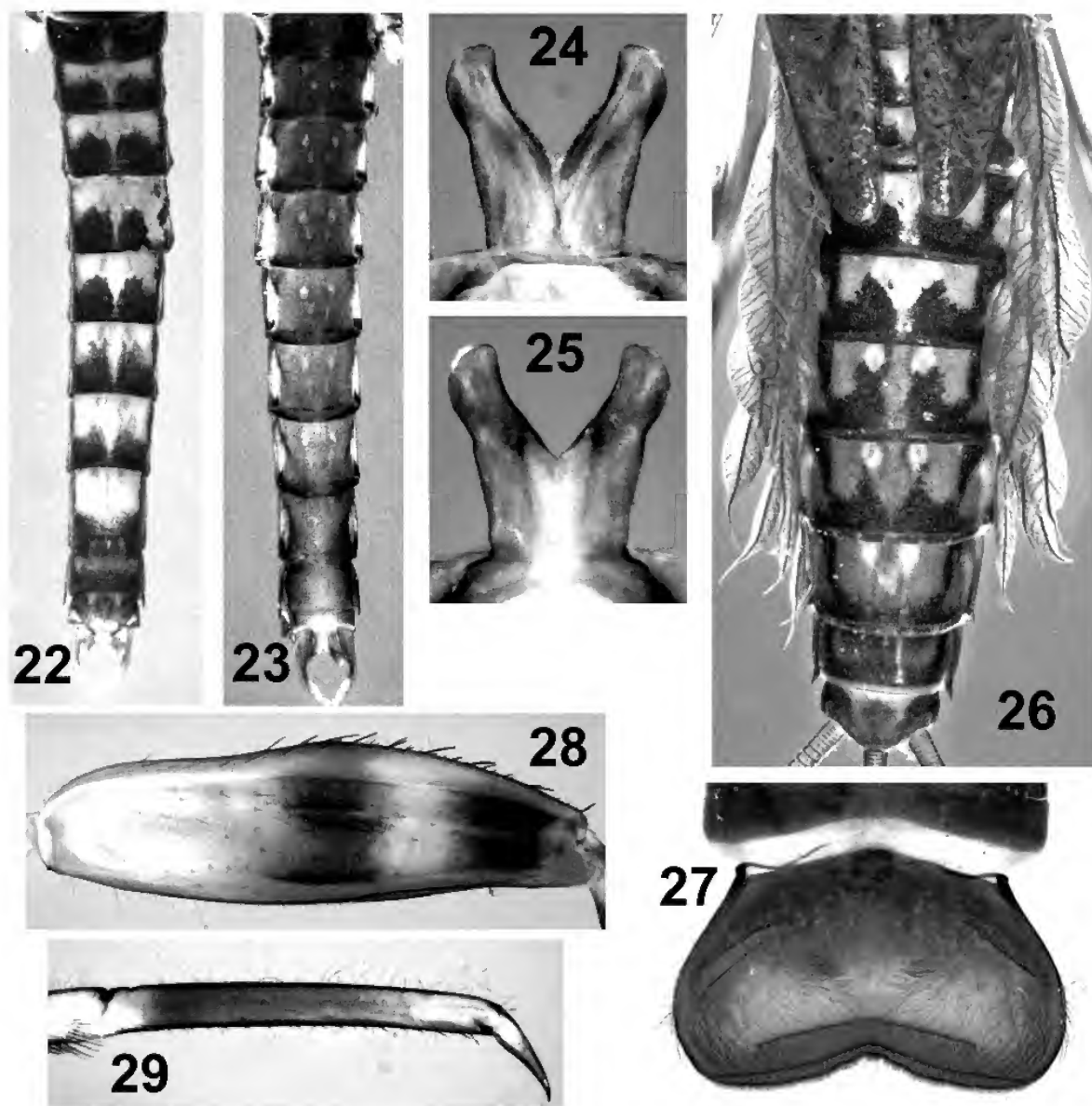
Figures 17–21. *Marmenuera ida*. Male imago: 17, forewing; 18, hindwing. Female imago: 19, forewing; 20, hindwing; 21, forewing, holotype.

male genitalia, and in the nymph by the abdominal colour pattern and the structure of the labrum and foreleg. Scholes (1961) referred this species to the genus *Massartellopsis*, presumably based on advice from Edgar Riek (CSIRO Division of Entomology), but it is now known that the genus *Massartellopsis* is endemic to South America.

Scholes (1961) suggested the common names “Large Speckled Spinner” and “Large Speckled Dun” for the imago and subimago respectively of *Marmenuera ida*, and we consider this appropriate.

Keys to species

- | | | | |
|-----------------|---|--|-----------------------------|
| 1. Adults | 2 | 2. Forewings heavily pigmented, crossveins around MA fork suffused with brown (figs 17,19); male imago with outer margin of penes lobes evenly rounded (fig. 24) | <i>Marmenuera ida</i> |
| – Nymphs | 3 | – Forewings lightly pigmented, crossveins around MA fork not suffused with brown (figs 1,3); male imago with outer margin of penes lobes angular (fig. 7) | <i>Marmenuera tillyardi</i> |
| | | 3. Foretarsus with 15–20 ventral spines (fig. 29); forefemur with spines along outer margin relatively long (fig. 28) | <i>Marmenuera ida</i> |
| | | – Foretarsus with 30–40 ventral spines (fig. 14); forefemur with spines along outer margin relatively short (fig. 13) | <i>Marmenuera tillyardi</i> |



Figures 22–29. *Marmenuera ida*. Male imago: 22, abdomen, dorsal; 23, abdomen, ventral; 24, penes, dorsal; 25, penes, ventral. Nymph: 26, abdomen, dorsal; 27, labrum; 28, forefemur; 29, foretarsus.

Acknowledgments

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References

- Christidis, F. 2005. Phylogenetic relationships of the Australian Leptophlebiidae (Ephemeroptera). *Invertebrate Systematics* 19: 531–59.
- Dean, J.C. 1999. *Preliminary keys for the identification of Australian mayfly nymphs of the Family Leptophlebiidae*. Identification Guide no. 20. Cooperative Research Centre for Freshwater Ecology, Albury, New South Wales. Pp iii + 91.
- Dean, J.C. 2000. Descriptions of new Leptophlebiidae (Insecta: Ephemeroptera) from Australia. II. *Kanina*, a new monotypic genus from south-western Australia. *Records of the Western Australian Museum* 20: 87–94.
- Dean, J.C.; Forteath, G.N.R. and Osborn, A.W. 1999. *Loamaggalangta pedderensis* gen. & sp.nov.: A new mayfly from Tasmania (Ephemeroptera: Leptophlebiidae: Atalophlebiinae). *Australian Journal of Entomology* 38: 72–76.
- Dean, J.C. and Suter P.J. 2004. Descriptions of new species and a new genus of leptophlebiid mayflies (Insecta: Ephemeroptera) from the Northern Territory, Australia. *Memoirs of the Museum of Victoria* 61: 111–18.
- Pescador, M.L. and Peters, W.L. 1980. Phylogenetic relationships and zoogeography of cool-adapted Leptophlebiidae (Ephemeroptera) in southern South America. Pp. 43–56 in: Flannagan, J.F. and Marshall, K.E. (eds), *Advances in Ephemeroptera Biology*. Plenum Press: New York.
- Plomley, N.J.B. 1976. *A word-list of the Tasmanian Aboriginal Languages*. Foot & Playsted: Launceston. Pp xv + 486.
- Scholes, D. 1961. *Fly-fisher in Tasmania*. Melbourne University Press: Carlton. Pp xiv + 208.
- Tillyard, R.J. 1936. The trout-food insects of Tasmania. Part II: A monograph of the mayflies of Tasmania. *Papers and Proceedings of the Royal Society of Tasmania*. 1935: 23–59.
- Towns, D.R. and Peters, W.L. 1980. Phylogenetic relationships of the Leptophlebiidae of New Zealand (Ephemeroptera). Pp 57–69 in: Flannagan, J.F. and Marshall, K.E. (eds), *Advances in Ephemeroptera Biology*. Plenum Press: New York.

A new species in the *Ophiocoma erinaceus* complex from the South-west Pacific Ocean (Echinodermata: Ophiuroidea: Ophiocomidae)

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Abstract

Benavides-Serrato, M. and O'Hara, T.D. 2008. A new species in the *Ophiocoma erinaceus* complex from the South-west Pacific Ocean (Echinodermata: Ophiuroidea: Ophiocomidae). *Memoirs of Museum Victoria* 65: 51–56.

A new species is described from the *Ophiocoma erinaceus* complex of tropical ophiuroids, reliably distinguished by the almost complete lack of granulation on the ventral disc surface. The new species is currently known only from the south-west Pacific Ocean, ranging from the northern section of the Great Barrier Reef to Tonga.

Keywords

Echinodermata, Ophiuroidea, *Ophiocoma*

Introduction

Ophiuroids of the genus *Ophiocoma*, common on coral or rocky reefs throughout the tropics, are difficult to identify and many historical records are inaccurate (Devaney 1968, Devaney 1970). Part of the problem has been the lack of distinctive morphological characters and the ability of some species to change colour pattern, from being consistently dark during the day to variegated at night (Hendler 1984, O'Hara *et al.* 2004). Devaney (1968, 1970) revised the taxonomy of the genus by introducing new taxonomic characters based around the shape of the oral and dental plates and their associated papillae. However, some problems were left unresolved.

One taxonomically problematic group contains black-coloured specimens with alternating numbers of arm spines from the Indo-Pacific Ocean generally known as *Ophiocoma erinaceus* (Müller & Troschel, 1842). The concept of this 'species' has varied widely from being considered a variety of the variegated species *O. scolopendrina* Lamarck, 1816 (eg Matsumoto, 1917) to being divided into species based on the number of tentacle-scales; two in *Ophiocoma erinaceus* and one in *O. schoenleinii* Müller & Troschel, 1842 (eg see Clark & Rowe, 1971). Devaney (1970) considered them 'polymorphs of the same species having phenotypically linked morphological characters'.

Field work across northern Australia led one of the authors (O'Hara) to consider that two species were indeed present, one with red-tube feet (*O. erinaceus*) and one with grey tube feet (*O. schoenleinii*). However, subsequent pilot molecular data suggested that three clades were present: with red-tube feet and two tentacle scales (*O. erinaceus*), grey-tube feet and one wide tentacle scale (*O. schoenleinii*), and grey-tube feet and two tentacle scales (undescribed) (O'Hara *et al.*, 2004).

Materials and methods

This paper is the formal scientific description of the third species in the complex, using a suite of morphological characters that include those of the dental plates introduced by Devaney (1970). The three known species in the complex are distinguished. Material examined for this paper is lodged in Museum Victoria, Melbourne (MV). The abbreviation d.d. is used for disc diameter.

Ophiocoma cynthiae sp. nov.

Figures 1, 2c, 2f

Material examined. Holotype: Queensland, Great Barrier Reef, Raine Island, shallow rocks off tower, 11°35.5'S, 144°2.3'E, 1–2 m, 5 Dec 2001, MV F112641 (ethanol, 17 mm d.d.).

Paratypes: Australia, Queensland, Great Barrier Reef, Raine Island, shallow rocks off tower, 11°35.5'S, 144°2.3'E, 1–2 m, 5 Dec 2001, MV F91535 (5 individuals, ethanol, d.d. 21 mm, 22 mm, 20 mm, 18 mm, 13 mm); Fiji, Naviti, 18°12'S, 178°11'E, 0–2 m, 7 Jul 2002, MV F101821 (1, ethanol, d.d. 21 mm); Tonga, Vaua'u, Keitahi, 18°36'S, 173°55'W, 0–2 m, 5 Oct 1983, MV F91614 (1, dry, d.d. 15 mm).

Comparative material examined. *Ophiocoma schoenleinii* Müller & Troschel. Australia, Queensland, Raine Island, shallow rocks off tower, 12 Dec 2001, 11°35.5'S, 144°2.3'E, 1–2 m, MV F101823 (1, ethanol, d.d. 15 mm); Moulter Cay, 11°21.4'S, 144°01.5'E, 1 m, 11 Dec 2001, MV F91534 (2, ethanol, d.d. 12 mm, 13 mm); Lizard Island, Coconut Beach, 14°40.8'S, 145°28.5'E, 2–5 m, 25 Oct 2005, MV F109814 (1, ethanol, d.d. 13 mm); Bird Island Reef, 14°4.6'S, 145°28'E, 5–15 m, 29 Oct 2005, MV F109813 (3, ethanol, d.d. 20 mm, 20 mm, 18 mm); Papua New Guinea, Bora Bada, MV F91583 (2, ethanol, d.d. 12 mm, 13 mm); Fiji, Naviti, 18°12'S, 178°11'E, 0–2 m, 7 Jul 2002, MV F93796 (1, ethanol, d.d. 20 mm); Vuda Point (between Nadi and Handtoka), 17°30'S, 177°25'E, 4 Jul 1981, MV F91593 (2, dry, d.d. 13

mm, 17 mm). *Ophiocoma erinaceus* Müller & Troschel. Western Australia, Ashmore reef, West lagoon, 12°14.29'S, 123°0.77'E, 3–9 m, 2 Oct 2002, MV F93633 (1, ethanol, d.d. 18 mm); Ashmore reef, west lagoon, 12°13.26'S, 122°59.28'E, 6–11 m, 1 Oct 2002, MV F93624 (5, ethanol, d.d. 13 mm, 11 mm, 13 mm, 6 mm, 5 mm); Queensland, Raine Island, shallow rocks off tower, 11°35.5'S, 144°2.3'E, 1–2 m, 5 Dec 2001, F91536 (2, ethanol, d.d. 15 mm, 20 mm); Moulter Cay, reef rim, 11°24.8'S, 144°01.9'E, 1–5 m, 10 Dec 2001, MV F91544 (1, ethanol); Lizard Island, First beach, 14°39.7'S, 145°26.8'E, 2–4 m, 28 Oct 2005, MV F109808 (1, ethanol, d.d. 19 mm).

Description. Holotype. Disc 17 mm d.d., pentagonal with slightly incised interradiar margins. Dorsal disc densely covered with rounded granules 0.15 mm diameter, 13–20 per mm², sparse or patchy near the arms bases and interradiar margins, covering radial shields. Ventral disc without granules,

covered in thick wrinkled epithelium, disc plates obscured; a few elongated spinelets occur in a row on either side of the genital slit adjacent to the oral shields.

Oral shields oval, longer (2.2 mm) than broad (1.9 mm), widest point a little distal of the midline, slightly depressed in the distal centre. Adoral shields triangular, much smaller than the oral shield, slightly lobed radial angle, restricted to the lateral edge of the oral shield, not meeting radially or interradially, margins obscured by epidermis (Fig. 1c). Four oral papillae on each side of jaw angle; inner is spiniform, twice as high as wide; second is triangular, wider than high; third is largest, two to three times as wide as high, longest proximally; last (buccal tentacle scale) is wide and low, up to four times as wide as high, proximal end extending under the third oral papilla. Ten to 11 dental

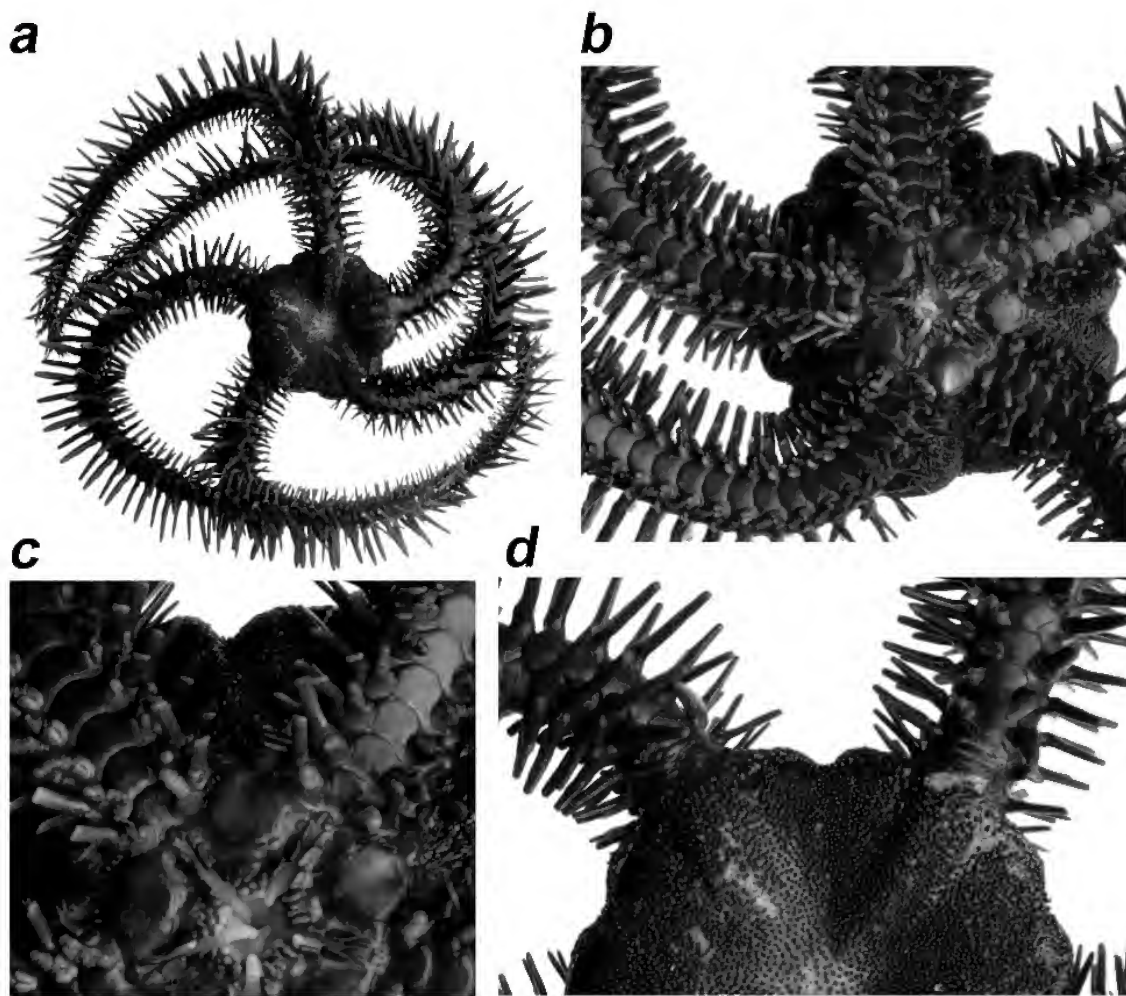


Figure 1. *Ophiocoma cynthiae* sp. nov. holotype (22 mm d.d.): a, dorsal surface of the whole animal; b, ventral surface; c, detail of oral frame; d, detail of the dorsal disc and arm surfaces.

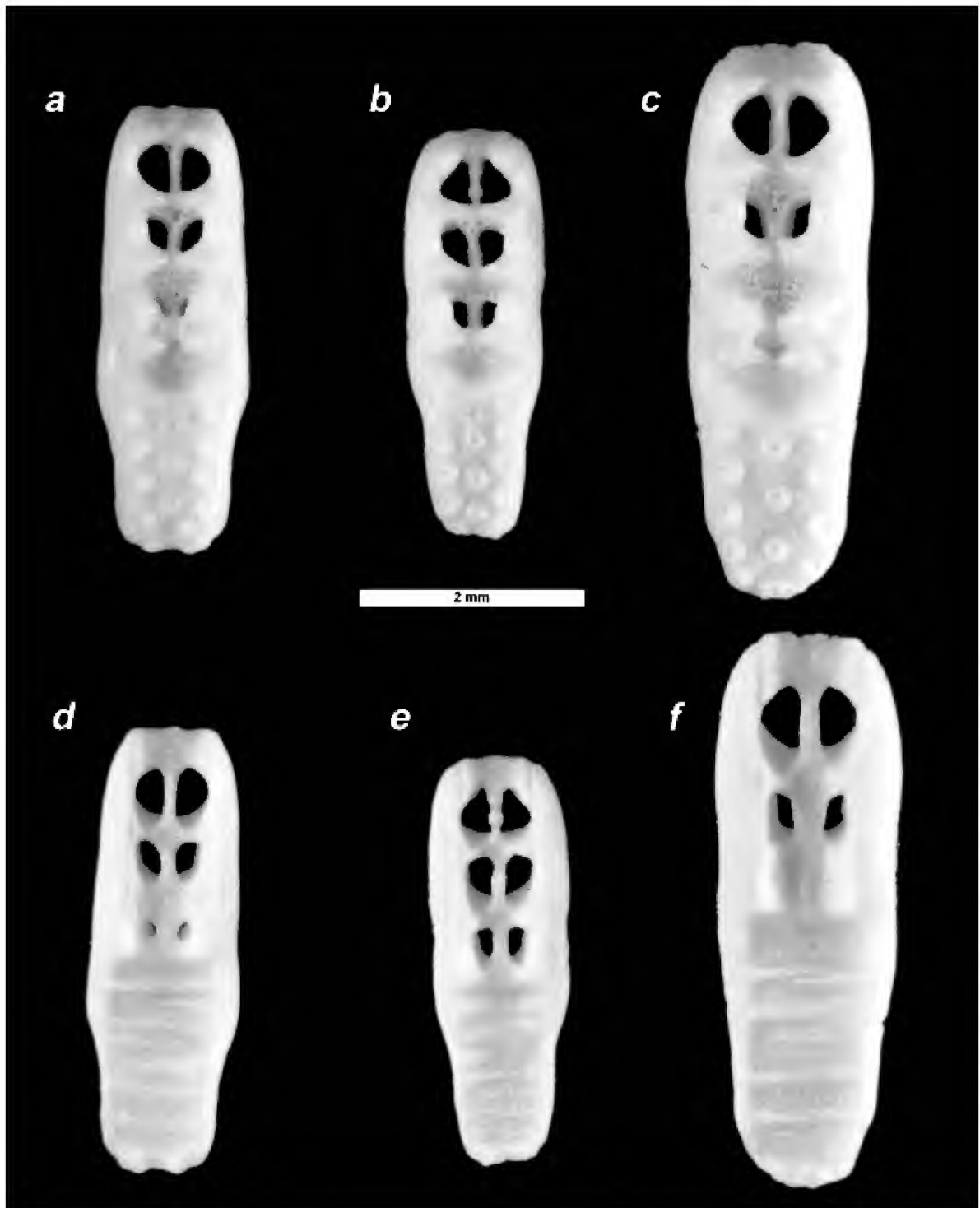


Figure 2. Dental plates of *Ophiocoma erinaceus* (MV F109808, 22 mm d.d.): a, external surface, d, internal, *Ophiocoma schoenleinii* (MV F109813, 21 mm d.d.): b, external; e, internal. *Ophiocoma cynthiae* sp. nov. (MV F91535, paratype 22 mm d.d.): c, external; f, internal.

papillae on each jaw, placed in three vertical rows near teeth, inner row slightly smaller, and an irregular transverse row or cluster across the jaw margin between the inner oral papillae; four hyaline tipped teeth in a vertical row, twice as wide as high.

First ventral arm plate much smaller than succeeding plates, with a straight or rounded proximal margin, straight to convex lateral sides and a convex distal margin, longitudinally grooved; second plate as wide as long, widest distally, with a convex distal edge, rounded lateral angles, recurved lateral sides and truncate proximal edge, often sunken proximally so that the distal edge of the first plate projects over the proximal edge of the second; succeeding plates 1.5 times broader than long, widest in the distal half of the plate, convex distal margin, sharp lateral angles, recurved lateral sides around tentacle pore, concave proximal edge overlain by preceding plate, plates in contact for more than half of arm length. Upper arm plates fan-shaped, usually wider than long, with a convex to truncate distal margin, straight divergent lateral sides and a slightly concave proximal border overlain by the preceding plate, plates contiguous throughout the arm, plates forming a zig-zag row after the fifth segment past the disc, displaced away from the enlarged alternating upper arm spines. Lateral arm plates separated from each other for all arm length.

Number of arm spines on each side of first twenty segments as follows (clockwise from the madreporite):

3	3	3	4	4	4	4	4	5	4	4	4	4	3	4	4	4	3	4
3	3	3	4	4	4	4	5	4	5	4	4	4	4	3	4	3	4	3
3	3	3	4	4	4	4	5	4	4	4	4	3	4	3	4	3	4	3
3	3	3	3	4	4	4	5	4	4	4	4	4	4	3	4	3	4	3
3	3	4	4	4	4	4	5	4	5	4	4	4	3	4	3	4	3	4
3	3	3	3	4	4	4	4	5	4	4	4	4	4	3	4	3	4	3
2	3	3	4	4	4	4	4	4	4	4	3	4	3	4	3	4	3	4
3	3	3	4	4	4	4	4	5	4	5	4	4	4	4	3	4	3	4
2	3	3	4	4	4	4	5	4	5	4	4	4	4	3	4	3	4	3
3	3	3	4	4	4	4	4	5	4	4	4	4	4	4	3	4	3	4

Arm spines of the first 5–7 segments flattened or curved, with truncate tips, subequal or uppermost longest, mostly longer than the ventral arm plate (except on first segment); spines on succeeding segments becoming progressively more cylindrical; spines start alternating 3–4 after segments 12–16, alternating uppermost spines become elongated and thickened, cigar- to club-shaped, longest in the middle of the arm, to three segments in length, 4–4.5 mm long, lower spines elongate and tapering; distal arm segments with three slender non-alternating spines. Two oval subequal tentacle scales on each pore, sitting side by side on the lateral arm plate, reducing to one near the arm tips.

Colour. Ethanol: Disc and arms uniform dark brown colour. Upper side spines of five first segments of arm spines with some white longitudinal bands along the edge; tube feet dark, with a pale tip near the mouth, oral tentacles pale; mouth frame basically tan with small dark spots, madreporite white.

Paratypes. A dental plate, dissected from one paratype (F91535, 22 mm d.d., Fig 2c), was 4.9 mm long and 1.7 mm wide, with

two foramina, the lower septa twice as thick as the upper one, and dental papillae confined to the upper third of the plate, which is slightly narrower than the rest of the plate. Paratypes generally had more elongate granules or spinelets along the genital slit, extending to 1/2R. On paratype F91614 the dorsal disc granules form a very regular sharp boundary at the edge of the disc and (since it is preserved dry) small thin overlapping ventral disc scales (0.20–0.25 mm wide) can be clearly seen extending from the lateral margin to the oral shield. The second oral papillae can sometimes be larger than the third, but this is not consistent on a specimen. There can be up to 17 dental papillae. Paratype F101821 differs in having ventral arm plates with a concave or slightly notched distal margin except near the arm tip, the dorsal arm plates are regularly arranged in a series, not alternating from side to side, and the maximum arm spine length is 8.6 mm. Paratypes F101821 and F91614 from Fiji and Tonga respectively, have a lighter colour than the holotype and paratypes (F91535) from Australia, the mouth frame is white and the arms have broad bands of dark and pale segments. This may represent the “night” colour form.

Distribution. Northern Great Barrier Reef, Fiji, Tonga, 0–2 m; under coral slabs or within dead coral matrix.

Etymology. This species is named after friend and tireless colleague Cynthia Ahearn, the former Museum Specialist in Echinoderms at the Smithsonian Institution who passed away in August 2008.

Remarks. The new species is clearly an *Ophiocoma* Agassiz as defined by Devaney (1970), possessing both dental and oral papillae, the latter in a continuous row, small adoral plates restricted to the lateral sides of the oral plate, a covering of spherical granules on the dorsal disc surface, and rounded arm spines in the middle of the arm. It belongs to the ‘scolopendrina’ group of species (Devaney 1970) with alternating numbers of arm spines and the uppermost arm spine enlarged. Within this group it shares many features in common with *O. erinaceus* including the dark colour, the presence of two to three arm spines on the first segment, the coarse disc granulation (10–20 per mm²) and the size of the upper arm spines, which are longer on the side with four spines.

Within, the *O. erinaceus* complex, *O. cynthiae* is distinguished by the lack of granules on the ventral disc surface (except for a few sparsely distributed along the genital slit near the oral shield). In *O. schoenleinii* they persist as a wedge near the ventral margin and extend almost to the oral shields in *O. erinaceus*. Furthermore, *O. schoenleinii* is distinguished by having only one wide tentacle scale on most pores past the first few segments, and denser dorsal disc granules (>20 per mm²). *Ophiocoma erinaceus* can be further distinguished by the colour of the tube feet: bright red in live specimens and white in ethanol-preserved ones.

Comparison of the dental plates of the three species (Fig. 2) indicates other possible differentiating characters. The dental plate of the new species is somewhat larger on specimens of similar size (21–22 mm d.d.), and is less narrowed on the region supporting the dental papillae. There are only two teeth foramina and the septum of second is much wider than the

first. The dental plates of the other two species have three foramina, but the third is much larger on *O. schoenleinii*. However, due to the low numbers of specimens of the new species we are reluctant to dissect additional material and the intraspecific or size-related variability of these characters is unknown at this stage.

This new species is similar to the description of the nominal species *Ophiocoma tartarea* Lyman, 1861, from Hawaii which was considered a synonym of *O. erinaceus* four years later by the same author (Lyman, 1865). In both his description of *O. tartarea* (1861) and *O. erinaceus* (1865) he refers to the absence of granules on the ventral disc surface, but without distinguishing between a wedge of granules and no granules at all. We have examined images of Müller & Troschel's type specimens in the Museum für Naturkunde Humboldt-Universität zu Berlin of both *O. erinaceus* (ZMB Ech 922) and *O. schoenleinii* (ZMB Ech 930, 4658). The type specimen of *O. erinaceus* clearly has a wedge of granules on the ventral interradial margin. The type specimens of *O. tartarea* appear to be lost. They were originally deposited in the museum of the Boston Society of Natural History (now called the Museum of Science), which transferred the majority of their collection in the 1940s to the Museum of Comparative Zoology in Harvard and some specimens to the United States National Museum. Downey (1969) does not list this species in her catalogue of US ophiuroid-type specimens, and there is no record of them in these museums today (Kirdahy, Ahearn & Boyett pers. comm.). Given the lack of available type material, the early synonymy of *O. tartarea* with *O. erinaceus* by the same author, and the lack of known records of specimens without any ventral granules from Hawaii, we proposed to erect a new species, *O. cynthiae*.

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References

- Clark, A.M. & Rowe, F.W.E. 1971. *Monograph of Shallow-water Indo-west Pacific Echinoderms*. Trustees of the British Museum (Natural History). London. 238 pp, 31 pls.
- Devaney, D.M. 1968. The systematics and Post-Larval growth changes in Ophiocomid brittlestars. PhD thesis. University of Hawaii. 272 pp.
- Devaney, D.M. 1970. Studies on ophiocomid brittlestars. I. A new genus (*Clarkcoma*) of Ophiocominae with a reevaluation of the genus *Ophiocoma*. *Smithsonian Contribution to Zoology* 51: 1–41.
- Downey, M.E. (1969). Catalog of recent ophiuroid type specimens in major collections in the United States. *Bulletin of the United States National Museum* 293: 1–239.
- Hendler, G. 1984. Brittlestar colour-change and phototaxis (Echinodermata: Ophiuroidea: Ophiocomidae). *Pubblicazioni Della Stazione Zoologica Di Napoli I (Marine Ecology)* 5: 379–401.
- Lyman, T. (1861). Descriptions of new Ophiuridae. *Proceedings of the Boston Society of Natural History* 8: 75–86.
- Lyman, T. (1865). Ophiuridae and Astrophytidae. *Illustrated Catalogue of the Museum of Comparative Zoology, Harvard University* 1: 1–200, pls 1–2.
- Matsumoto, H. (1917). A monograph of Japanese Ophiuroidea, arranged according to a new classification. *Journal of the College of Science, Imperial University Tokyo* 38(2): 1–408, pls 1–7.
- Müller, J. & Troschel, F.H. 1842. *System der Asteriden*. Von Friedrich Vieweg und Sohn, Braunschweig. 134 pp., 12 pls.
- O'Hara, T.D., Byrne, M., & Cisternas, P. 2004. The *Ophiocoma erinaceus* complex: another case of cryptic speciation in echinoderms: pp. 537–42 in Heinzeller, T. & Nebelsick, J.H. (eds). *Echinoderms: München: Proceedings of the 11th International Echinoderm Conference, Munich, Germany, 6–10 October 2003*, A.A. Balkema, The Netherlands.



A new species in the genus *Ophiomyxa* from South-west Australian waters (Echinodermata: Ophiuroidea: Ophiomyxidae)

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Abstract

Franklin, A.M. and O'Hara, T.D. 2008. A new species in the genus *Ophiomyxa* from South-west Australian waters (Echinodermata: Ophiuroidea: Ophiomyxidae). *Memoirs of Museum Victoria* 65: 57–62.

A new species is described from the genus *Ophiomyxa* collected from south-west Australia. It is distinguished by the lack of marginal plates, three arm spines, the uppermost reaching up to 2 segments in length, and a characteristic pattern of reduced dorsal arm plates. Current evidence suggests it is endemic to waters around 400m deep off the coast of south-western Australia.

Keywords

Echinodermata, Ophiuroidea, *Ophiomyxa*

Introduction

Knowledge regarding the diversity of ophiuroids from the south-west of Australia is rather limited. A recent survey coordinated by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2005 sought to validate multiple use management frameworks and characterise marine ecosystems in this area. Epibenthic sleds were used to collect invertebrate epifauna. Through this sampling process, many ophiuroid specimens belonging to an undescribed species in the family Ophiomyxidae were collected.

The Ophiomyxidae are a small taxonomically problematic family of ophiuroids that were originally placed with basket and serpent stars in the order Phrynophiurida (Matsumoto 1915), but more recently with the other simple-armed brittle-stars in the order Ophiurida (Smith *et al.* 1995, Janies 2001). The characteristic covering of thick skin and reduction of skeletal plates have been considered a primitive (Matsumoto 1917) or derived trait (Byrne *pers. comm.*).

This paper is the formal scientific description of the new species of *Ophiomyxa* Müller & Troschel, 1842. A suite of morphological characteristics are used to distinguish the new species including the presence and shape of dorsal arm plates, the length and number of arm spines and the location of ossicles. The material examined in this study is lodged in the Museum of Victoria, Melbourne (MV) and the Western Australian Museum (WAM). The abbreviation d.d. is used for disc diameter.

Taxonomy

Ophiomyxa crinita sp. nov.

Figures 1 & 2

Material examined. (all from the RV Southern Surveyor expedition SS10/2005 to south-western Australia).

Holotype: Off Lancelin, 31° 0.75'S, 114° 49.5'E, 394–393m, 1 Dec 2005, (stn 75), WAM Z21290.

Paratypes: as holotype, MV F111566(n=199).

Other material: Off Zuytdorp, 27° 8.01'S, 112° 45.06'E, 414–405m, 5 Dec 2005, (stn 105), MV F111951, (2). Off Bunbury, 33° 0.504'S, 114° 34.26'E, 421–414m, 20 Nov 2005, (stn 13), F111561(103). D'Entrecasteaux, 35° 4.176'S, 115° 20.16'E, 378–379m, 21 Nov 2005, (stn 17), MV F111562(2). Off Albany, 35° 21.882'S, 118° 18.42'E, 398–407m, 23 Nov 2005, (stn 25), MV F111563(1). Two Rocks, 31° 37.08'S, 114° 58.32'E, 364–404m, 19 Nov 2005, (stn 4), MV F111559(15); 31° 36.528'S, 114° 58.86'E, 329–370m, 19 Nov 2005, (stn 6), MV F111560(2). Off Bunbury, 33° 0.582'S, 114° 34.2'E, 423–397m, 29 Nov 2005, (stn 67), MV F111564, (100). Perth Canyon, 31° 59.544'S, 115° 10.98'E, 508–478m, 29 Nov 2005, (stn 68), MV F111565(1). Off Jurien Bay, 29° 52.062'S, 114° 23.22'E, 414–401m, 2 Dec 2005, (stn 78), MV F111567(5); 29° 50.514'S, 114° 21.72'E, 408–427m, 2 Dec 2005, (stn 80), MV F111568(1); MV F111935(28). Off Abrolhos Islands, 28° 59.4'S, 113° 45.9'E, 389–407m, 3 Dec 2005, (stn 90), MV F111661(5).

Holotype description. 19 mm d.d. with slightly indented interrational margins. Disc covered with a thick, fairly smooth epithelium obscuring the limits of the radial shields, oral and adoral shields and oral plates (fig. 1C). No series of interrational marginal plates. Bursal slits 5 mm long, ending 1 mm before

the disc margin at the end of the 4th arm segment, not bordered by spines or papillae.

Arms are approximately 110 mm long and 3 mm wide at the base. The dorsal, ventral and lateral arm plates are hidden from view by a thick epithelium which extends to cover the arm spines but does not create any webbing (fig. 1B&C). Segments have 3 spines per side, reducing to 2 distally, positioned ventro-laterally. The dorsal-most spine resides on the lateral midline and is the widest (0.8 mm at the arm base). At the base of the arm the dorsal spine is longest (3.4 mm), about 2 segments long, the middle spine is just longer than a segment and the ventral spine is slightly shorter. Midway down the arm the dorsal spine shortens to about 1.5 segments long, the middle spine is slightly longer and the ventral spine equal to a segment. Distally, the ventral spine is longest; approximately a segment long. The dorsal spine is about 0.5 segments long and when the middle spine is present it is slightly shorter than a segment. Damage to the specimen has removed skin from some spines. Without skin, proximal spines are conical and smooth, gradually changing to become slightly serrated on 2 sides by mid-arm and becoming serrated and comb-like (but not hooked) on 1 side distally. No tentacle scales; the tube feet do not have a calcareous tube around the base.

Each side of the jaw angle has 3 oral papillae which are separate from each other. Two jaw angles also bear a 4th very small, triangular oral papilla, positioned distally. The middle papillae are 2 times higher than wide and generally triangular, sometimes rounded, in shape with denticulated tips. The innermost papillae are 2-3 times higher than wide, ovoid and also with a denticulated edge. The apical papillae are largest, generally about as high as they are wide, much rounder and not as denticulate. The distal oral tube feet are located in the mouth, near the ventral surface and are not covered by protecting scales.

Paratypes. Range from 11 mm – 22 mm in d.d., juveniles resemble small adults. Dorsal and ventral skin from a 19 mm d.d. paratype were partially dissolved in bleach. This disc epithelium contained 2-3 layers of transparent, overlapping oval plates, ranging in size from 182 μm – 303 μm wide and 136 μm – 409 μm long, flat and smooth, showing varying degrees of perforation (fig. 2E). Perforations usually cover the entire plate but some are only perforated in the middle. The perforated plates are more common near the radial shields and the bursal slits. C-shaped ossicles are scattered throughout the stomach wall, occasionally in small clusters, typically 76 μm long and 38 μm wide (fig. 2F).

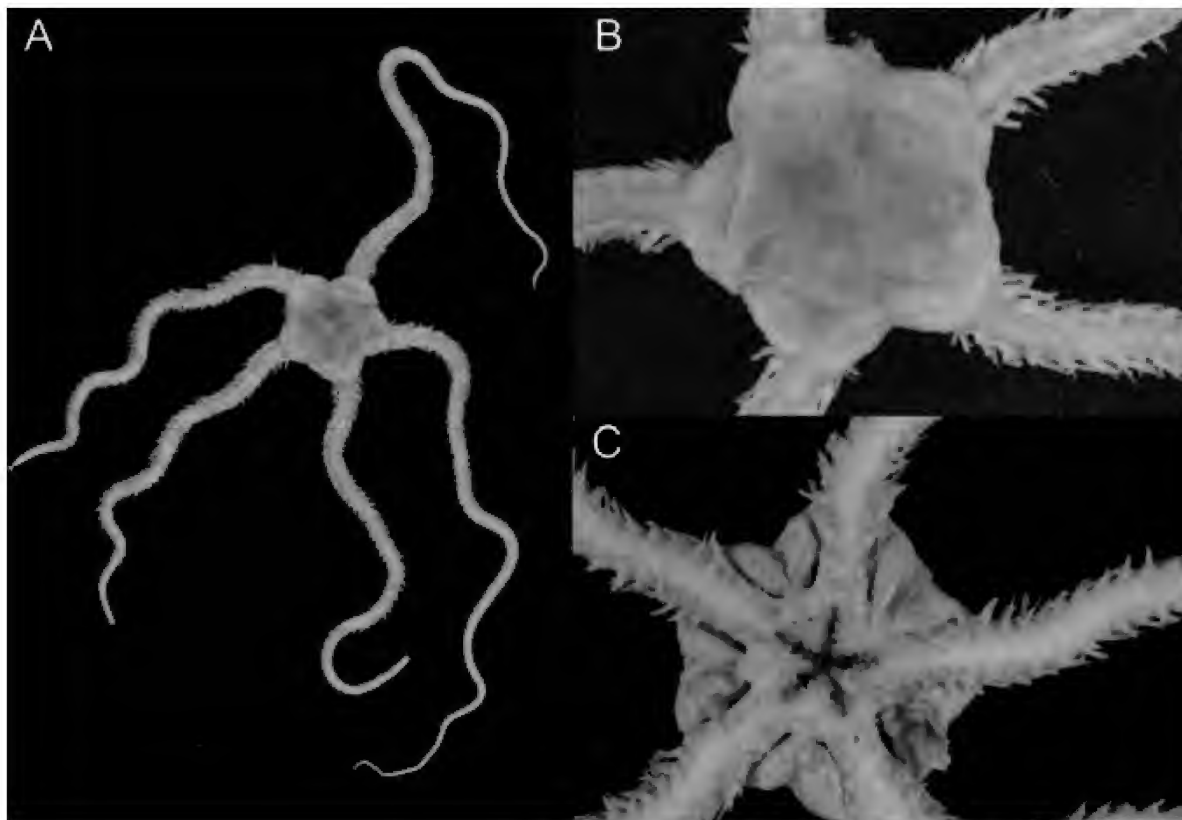


Figure 1: *Ophiomyxa crinita* sp. nov. holotype (19 mm d.d.) in A, dorsal view; B, detail of dorsal disc; C, detail of ventral disc and mouthparts.

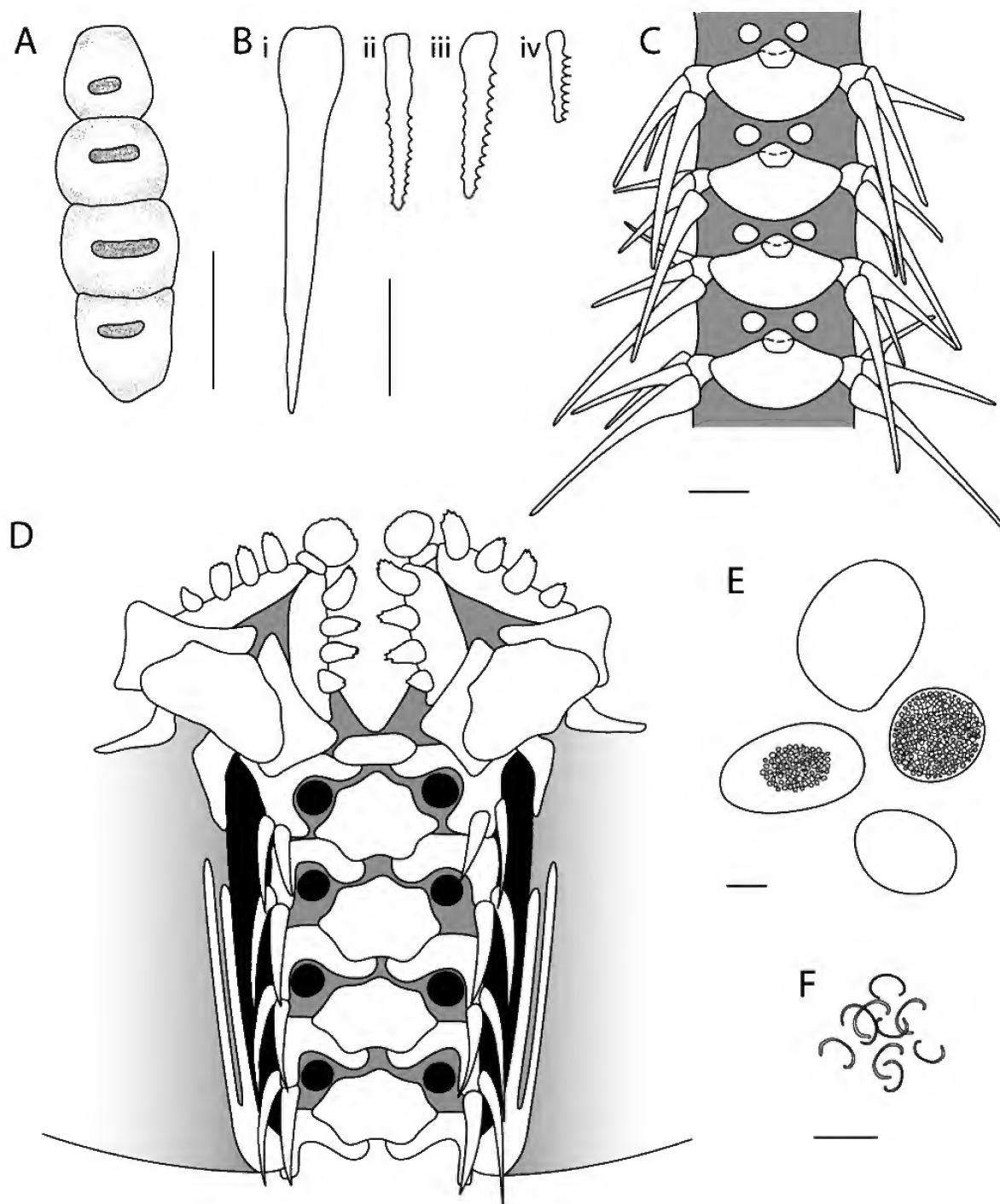


Figure 2. *Ophiomyxa crinita* sp. nov., A, dental plate; B, arm spines, i, dorsal at base of arm, ii, middle at proximal mid arm, iii, middle at distal mid arm, iv, ventral at tip of arm; C, dorsal view of arm, skin removed; D, ventral view of arm and mouth parts, skin removed; E, plates from disc skin; F, ossicles from stomach wall. Scale bars A-D: 1 mm, E&F: 0.1 mm.

Radial shields are approximately 2 mm long, 1/10 d.d., 3 times longer than wide, rectangular in shape, with curved edges and angled inwards at the proximal end. Ventrally, the adradial genital scale articulates with the radial shield, but it is not visible. The abradial genital scale is visible and shaped like a two pronged fork (fig. 2D). Proximal to the abradial scale is a line of small irregularly shaped, perforated plates terminating in an L-shaped plate partially overlapped by the oral shield.

The dorsal arm plates do not extend onto the disc, are rhombic in shape, 2.25 mm wide and 1.15 mm long proximally, about 2 times wider than long. The lateral corners are rounded, the distal edge is convex, the proximal edges are slightly concave and the proximal tip is indented and overlain by another pentagonal plate, 0.7 mm wide and 0.5 mm long (fig. 2C). Proximal to this plate are two small, round plates which are slightly pointed on their inner edges. Residing on either side of the midline, they do not touch any other plates.

Ventral plates, 1.20 mm long and 1.70 mm wide, are about 1.5 times wider than long, shaped like slightly flattened heptagons with proximal ends pointed and distal ends indented, the angles are rounded and edges slightly concave (fig. 2D). The proximal edge curves around the lateral plates and the tentacle pores. The 1st ventral plate is shaped like a flattened hexagon, 3 times wider than long. Lateral arm plates extend from near the ventral midline to just past the lateral midline touching the edge of the dorsal plates. They bear a slight dome on the edge of the arm, the distal edge of which has three small articulation ridges, one for each arm spine.

Oral shields are oval, with a small point proximally and slightly wider distally, about 2 times wider than long (fig. 2D). Adoral shields are pentagonal, about as wide as long, and follow the proximal and lateral edges of the oral shield and do not touch radially or interradially.

Dental plates are divided by transverse fissures into 4 pieces each supporting a tooth about the same size and shape as the apical papillae, or first tooth. The middle two pieces are square with rounded lateral edges, the end two pieces are triangular, and all have curved corners (fig. 2A). Each has a rectangular groove in the middle where the tooth sits and the ventral piece also supports the apical papilla. Oral plates are about two times longer than high and are axe shaped in lateral view with the ventral edge curving up as it nears the jaw apex. Vertebrae have a V-shaped aboral groove and a smooth aboral surface.

Variations from the holotype include a thicker, wrinklier epithelium, slightly pinker on the dorsal surface. Oral papillae number either 4 or 3 on all jaw angles and some may touch (fig. 2D). They vary in how triangular or broad they are, generally more broad apically. The dental plate may bear a 5th pointed, small tooth dorsally.

Colour (Live specimens). The dorsal disc is peach-brown in colour, slightly lighter on the arms and fading to cream at the tips. There are some tan and some cream spots on the dorsal disc surface, with the cream spots being smaller. The ventral disc surface, mouth frame and spines are a bright white and the tube feet are a transparent white. Tests for bioluminescence were negative (Mallefet & O'Hara, unpublished data).

Colour (Preserved in ethanol). The disc is pale pink-brown dorsally and white ventrally. The middle of the disc is pale grey

due to the internal organs. The tube feet are tan whilst the mouth frame is cream. The spines when covered with skin are cream, but transparent and glassy where the skin has been removed.

Etymology. *crinita* (Latin, f.), long haired, in reference to the relatively long arm spines.

Distribution. South-western Australia from off Albany to Zuytdorp, 329-508 m.

Remarks. This species belongs to the genus *Ophiomyxa* due to the presence of a thick skin covering the disc and arms, denticulate glassy oral papillae, fragmented dorsal arm plates, and the second oral tentacle opening within the jaw slit (Matsumoto 1917; Fell 1960).

Within *Ophiomyxa*, the species falls into a group of species previously distinguished as the genus *Ophiodera* Verrill, 1899 that are characterised by the absence of a row of marginal interradial plates that run between the pairs of radial shields. *Ophiodera* is not currently recognised, as the designated type species *O. serpentaria* has the intermediate condition of a few rudimentary marginal plates near the radial shields (Mortensen 1927). However, there may be some merit in a grouping of these species, with other potential synapomorphies including similar shaped oral plates and long pointed arm spines that become serrated on distal segments. Whatever the status of *Ophiodera*, these characters are useful diagnostically within *Ophiomyxa*.

Of the species without marginal plates, *Ophiomyxa crinita* is most similar to *Ophiomyxa neglecta* (Koehler, 1904), sharing a similar number of arm spines, similar shaped dorsal and ventral plates and denticulate oral papillae. However, *Ophiomyxa neglecta* has small arm spines that are less than one segment long, ventral plates of similar length and width, radial shields about 1/5 of the disc diameter, and C-shaped ossicles in the disc and arm epithelium (Koehler 1922). *Ophiomyxa anisacantha* H.L. Clark, 1911, *Ophiomyxa bengalensis* Koehler, 1897, *Ophiomyxa compacta* (Koehler, 1905), and *Ophiomyxa punctata* (A.H. Clark, 1952) all have four, often five arm spines (see also Irimura 1982; Imaoka *et al.* 1990). The dorsal arm plates of *O. anisacantha*, *O. bengalensis* and *O. punctata* are divided into several small, oval scales whereas in *O. punctata* this only occurs on the first 2 segments and the other segments bear no plates. The arm spines of *O. anisacantha* are shorter than *O. crinita* and also differ in having the ventral arm spine of equal length to the dorsal spine. *Ophiomyxa punctata* has short black lines parallel to the genital slits and *O. compacta* has no genital scale and oral papillae that are not denticulated. All of these species are from the tropical Indo-Pacific region.

Two other species have been referred to *Ophiodera* from the Atlantic Ocean: *O. serpentaria* Lyman, 1883 and *O. stimpsonii* (Lyman, 1875). They both have at least a few marginal disc plates and lack dorsal arm plates (Verrill 1899; Paterson 1985). *Ophiomyxa stimpsonii* has more than four short arm spines and five oral papillae. *Ophiomyxa serpentaria* has lateral plates that may be fused to the ventral plates (Verrill 1899).

The new species is sympatric with the widespread Indo-Pacific species *Ophiomyxa australis* Lütken, 1869, which can be distinguished by the presence of the marginal row of disc

plates, up to seven short arm spines often webbed with skin, and a different pattern of dorsal plate fragmentation (Mortensen 1924; Irimura 1982).

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References

- Clark, A.H. 1952. Echinoderms from the Marshall Islands. *Proceedings of the United States National Museum*, 102: 265-303.
- Clark, H.L. 1911. North Pacific ophiurans in the collection of the United States National Museum. *Bulletin of the United States National Museum*, 75: 1-302, figs 1-144.
- Fell, H.B. 1960. Synoptic keys to the genera of Ophiuroidea. *Zoological Publications of the Victoria University Wellington*, 26: 1-44, 6 figs.
- Imaoka, T., Irimura, S., Okutani, T., Oguro, C., Shigei, M. & Horikawa, H. 1990. *Echinoderms from continental shelf and slope around Japan Vol. 1*. Japan Fisheries Resource Conservation Association, Tokyo: 159 pp.
- Irimura, S. 1982. *The Brittle-stars of Sagami Bay*. Biological Laboratory, Imperial Household, Japan: 95 pp, 15 pls.
- Janies, D. 2001. Phylogenetic relationships of extant echinoderm classes. *Canadian Journal of Zoology* 79: 1232-50.
- Koehler, R. 1897. Échinodermes recueillis par l'Investigateur dans l'Océan Indien. I. Les ophiures de mer profonde. *Annales des Sciences Naturelles, Zoologie*, 8: 277-372, pls 5-9.
- Koehler, R. 1904. Ophiures de mer profonde. *Siboga-Expeditie*, 45: 1-176, pls 1-36.
- Koehler, R. 1905. Ophiures littorales. *Siboga-Expeditie Monographs*, 45: 1-142, pls 1-18.
- Koehler, R. 1922. Contributions to the biology of the Philippine Archipelago and adjacent regions. Ophiurans of the Philippine seas and adjacent waters. *Bulletin of the United States National Museum*, 100: 1-486, pls 1-103.
- Lütken, C.F. 1869. Addimenta ad historiam Ophiuridarum. 3. Beskrivende og kritiske Bidrag til Kundskab an Slangestjernerne. *Kongelige Danske Videnskabernes Selskabs Skrifter*, 5(8): 22-109.
- Lyman, T. 1875. Zoological results of the Hassler Expedition. 2. Ophiuridae and Astrophytidae. *Illustrated Catalogue of the Museum of Comparative Zoology, Harvard University*, 8: 1-34, 5 pls.
- Lyman, T. 1883. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Caribbean Sea in 1878-79, and among the Atlantic coast of the United States during the summer of 1880, by the U.S. Coast Survey steamer *Blake*, Commander J.R. Bartlett, U.S.N., commanding. XX. Report on the Ophiuroidea. *Bulletin of the Museum of Comparative Zoology, Harvard University*, 10: 227-287, pls 1-8.
- Matsumoto, H. 1915. A new classification of the Ophiuroidea: with descriptions of new genera and species. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 67: 43-92.
- Matsumoto, H. 1917. A monograph of Japanese Ophiuroidea, arranged according to a new classification. *Journal of the College of Science, Imperial University Tokyo*, 38: 1-408, figs 1-100, pls 1-7.
- Mortensen, T. 1924. Echinoderms of New Zealand and the Auckland-Campbell Islands. II. Ophiuroidea. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening*, 77: 91-177, figs 1-36, pls 3-4.
- Mortensen, T. 1927. *Handbook of the Echinoderms of the British Isles*. Oxford University Press, London: 471 pp. 269 figs.
- Müller, J. & Troschel, F.H. 1842. *System der Asteriden*. Friedrich Vieweg und Sohn, Braunschweig: 134 pp. 12 pls
- Paterson, G.L.J. 1985. The deep-sea Ophiuroidea of the North Atlantic Ocean. *Bulletin of the British Museum (Natural History)*, 49: 1-162, figs 1-59.
- Smith, A.B., Paterson, G.L.J. & Lafay, B. 1995. Ophiuroid phylogeny and higher taxonomy: morphological, molecular and palaeontological perspectives. *Zoological Journal of the Linnean Society of London*, 114: 213-243.
- Verrill, A.E. 1899. Report on the Ophiuroidea collected by the Bahama expedition in 1893. *Bulletin of the Laboratories of Natural History of the State of Iowa*, 5: 1-88, pls 1-8.



Deep-sea majoid crabs of the genera *Oxypleurodon* and *Rochinia* (Crustacea: Decapoda: Brachyura: Epialtidae) mostly from the continental margin of Western Australia

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Abstract

Richer de Forges, B., and Poore, G.C.B. 2008. Deep-sea majoid crabs of the genera *Oxypleurodon* and *Rochinia* (Crustacea: Decapoda: Brachyura: Epialtidae) mostly from the continental margin of Western Australia. *Memoirs of Museum Victoria* 65: 63–70.

Two species are newly described from the continental margin of Western Australia: *Oxypleurodon wilsoni* and *Rochinia annae*. *Oxypleurodon luconicum*, *Rochinia carinata*, *R. pulchra*, *R. sibogae* and *R. strangeri* are newly reported from Western Australia. *Rochinia fultoni* and *R. mosaica* from south-eastern Australia are refigured.

Keywords

Decapoda, Brachyura, Epialtidae, new species, Indian Ocean, Australia

Introduction

The decapod crustacean fauna along the south-western and central continental margin of Western Australia has been recently revealed to be highly diverse and novel (Poore et al., 2008). These discoveries result from recent sampling, part of a project mounted by CSIRO Marine and Atmospheric Research (CMAR) and Museum Victoria entitled “Mapping benthic ecosystems on the deep continental shelf and slope in Australia’s South West Region”.

This contribution on majoid crabs is based on the collections made during the southern phase of this project (cruise SS10-2005) and on those taken during a second phase along the northern Western Australian continental margin (cruise SS05-2007).

Our classification of the Majoidea follows Ng et al. (2008). Poore et al. (2008) reported on 14 species of Epialtidae (3 probably new species), two species of Hymenosomatidae (one new), 20 species of Inachidae (two new) and 13 species of Majidae (three new). Of these 49 species, nine were reckoned to be new records of Indo-West Pacific species for Australia. This paper reports only on the epialtid genera *Oxypleurodon* Miers, 1886, and *Rochinia* Milne Edwards, 1875, other members of this family from these collections being relatively well known.

We remark on other species of *Rochinia* in the collections of Museum Victoria (NMV). Types are lodged in the Western Australian Museum (WAM) and Museum Victoria.

Measurements are given as greatest length (without pseudorostrum) and greatest width.

Epialtidae MacLeay, 1838

Remarks. Poore et al. (2008) listed 14 species in this family from the south-western Australian collections. Of these, *Austrolibinia gracilipes* (Miers, 1879), *Hyastenus convexus* Miers, 1884, *Naxioides robillardi* (Miers, 1882), *N. taurus* (Pocock, 1890), *N. tenuirostris* (Haswell, 1880), *Phalangipus filiformis* Rathbun, 1916, and *P. hystrix* (Miers, 1884) were new records for southern or all Western Australia. They also reported *Griffinia lappacea* (Rathbun, 1918) and *Lahaina agassizii* (Rathbun, 1902) which were previously known. One specimen, which could not be identified at the time, belongs to a species of *Thacanophrys*.

Oxypleurodon Miers, 1886

Remarks. *Oxypleurodon* was redefined and separated from other similar genera by Tavares (1991) and several species from the Indo-West Pacific were reviewed by Richer de Forges (1995). Ng and Richer de Forges (2007) listed the 17 species known. Davie (2002) included the genus in the subfamily Pisinae of family Majidae. Following Ng et al. (2008) it is now in the family Epialtidae MacLeay, 1838, included inside the superfamily Majoidea. One species has been previously recorded from Australia, *O. stimpsoni* Miers, 1886, from Queensland (Davie, 2002). Here, a second species is newly

recorded for Australia and a third species is described as new from Western Australia.

***Oxypleurodon luzonicum* (Rathbun, 1916)**

Figure 1a

Sphenocarcinus luzonicus Rathbun, 1916: 539.—Estampador, 1937: 552.—Estampador, 1959: 112.—Griffin, 1976: 211, fig. 11a.—Serène and Vadon, 1981: 124, pl. 4E.—Guinot and Richer de Forges, 1986a: 138, fig. 19A, B, 21C, D, pl. 8 figs A–F.—Guinot and Richer de Forges, 1986b: 29.—Richer de Forges, 1992: 4.

Rochinia luzonica.—Griffin and Tranter, 1986a: 180.—Tavares, 1991: 161.—Webber and Richer de Forges, 1995: 514.

Oxypleurodon luzonicus.—Richer de Forges, 1995: 48, fig. 1B, pl. 2A.

Oxypleurodon luzonicum.—Ng and Richer de Forges, 2007: 63.

Material examined. Australia. WA. Leveque L27 transect (15°00.52'S–14°59.05'S, 121°38.08'E–121°39°10'E), 205–211 m, 25 Jun 2007 (stn SS05/2007 099), NMV J58221 (2 females 11.7 x 9.7 mm, 11.8 x 10.1 mm; juvenile 5 x 3.9 mm).

Remarks. These specimens from the northern part of the Western Australian continental slope fit well with the description of *O. luzonicum* from the Philippines. These records extend the distribution of the species considerably south, to 15°S in the western Indian Ocean. The species' distribution does not overlap with that of another *Oxypleurodon* from the southern part of the Western Australian slope which is described below as a new species.

***Oxypleurodon wilsoni* sp. nov.**

Figure 1b

Rochinia aff. *luzonica*.—Poore et al., 2008: 56 (colour fig.).

Material examined. Holotype: Australia. WA. Off Two Rocks (31°36.32'S–31°37.02'S, 114°58.52'E–114°58 16'E), 329–370 m, 19 Nov 2005 (stn SS10/2005 006), WAM C400529 (ovigerous female 15.7 x 15.4 mm).

Paratypes. Collected with holotype, WAM C400530 (ovigerous female, 16.4 x 14.0 mm). WA. Off Abrolhos (29°00.46'S–29°01.23'S, 113°46.44'E–113°47.06'E), 419–439 m, 03 Dec 2005 (stn SS10/2005 088), NMV J54070 (male, 18.5 x 19.6 mm). Off Two Rocks (31°37.05'S–31°37.23'S, 114°58.19'E–115°14.39'E), 364–404 m, 19 Nov 2005 (stn SS10/2005 004), NMV J54069 (3 males, 14.4 x 13.5 mm, 13.9 x 13.4 mm, 9.6 x 8.8 mm).

Diagnosis. Carapace to 18.5 mm, long, pyriform. Carapace, including pseudorostral spines, covered with short setae. Carapace bearing several elevated plates and tubercles arranged as follows: 1 cardiac plate, round and forming a conical point in its middle; 2 branchial plates, thin, sharp and pointing laterally; 2 epibranchial plates, thin, sharp and oriented obliquely; 1 ovoid mesogastric plate; 2 hepatic plates touching the postocular plates forming together a L-shape; 1 small subbranchial oblong plate on the lateral border; 2 supraocular plates, sharp anteriorly; 1 anterogastric tubercle; 1 tubercle on each side of mesogastric plate; posterior border of the carapace thick, forming medially a large tooth pointing backward. Pseudorostral spines long and sharp, diverging in a V. Eyes small, completely inserted in the orbits, the postocular

plate forming a cup. Basal antennal article fused with carapace. Cheliped shorter than pereopod 2. Articles of ambulatory legs cylindrical. Female abdomen of 7 segments.

Distribution. South-western WA slope (29°–31.5°S), 329–439 m depth.

Etymology. Dedicated to Dr Robin Wilson in recognition of his enthusiasm and hard work during the cruise when this species was collected, and at all times.

Remarks. *Oxypleurodon wilsoni* sp. nov. belongs in the group of species of *Oxypleurodon* having long and sharp branchial plates: *O. luzonicum* (Rathbun, 1916), *O. stuckiae* (Guinot and Richer de Forges, 1986b), *O. karubar* Richer de Forges, 1995, and *O. lowryi* (Richer de Forges, 1992).

In *O. wilsoni* the supraocular plate is sharp anteriorly whereas it is rounded in *O. luzonicum*. The cardiac plate is small, round and elevated in the middle (round and flat in *O. luzonicum*). The epibranchial plates are oblong, pointing externally in *O. wilsoni* but small and triangular in *O. luzonicum*. The mesogastric plate is ovoid but lozenge-shaped in *O. luzonicum*. Between the mesogastric spine and the hepatic spine lies a small tubercle absent in *O. luzonicum*.

O. wilsoni is distinguishable from *O. stuckiae* by the presence of a supraocular spine. The pseudorostral spines are longer and less diverging in *O. wilsoni* than in *O. stuckiae*. An anterior gastric tubercle in *O. wilsoni* is not seen in *O. stuckiae*.

O. wilsoni differs from *O. karubar* in the following characters: the epibranchial plate is straight but curved in *O. karubar*; the pseudorostral spines are straight but enlarged basally in *O. karubar*; the anterior part of the supraocular plate is spiniform in *O. wilsoni* but rounded in *O. karubar*; the hepatic plate touches the postocular plate forming together an L-shape in *O. wilsoni* but these are several disjointed pieces in *O. karubar*.

The shape of the carapace is pyriform in *O. wilsoni* while it is large and rounded posteriorly in *O. lowryi*. The supraocular plate points forward in *O. wilsoni* but laterally in *O. lowryi*. The branchial spines are straight in *O. wilsoni* while they are curved in *O. lowryi*.

The ambulatory legs of the holotype and paratype from the same sample are mixed and it is not possible to be precise about the relative lengths of pereopods.

The species was collected over narrow latitudinal and depth ranges.

***Rochinia* Milne-Edwards, 1875**

Remarks. *Rochinia* was redefined by Tavares (1991) updating the extensive revision by Griffin and Tranter (1986a) who provided a key to 29 species of a more inclusive genus. Davie (2002) included the genus in the subfamily Pisinae of family Majidae. Five species have been previously recorded from Australia (Davie, 2002). Ng and Richer de Forges (2007) listed the 24 species known from the Indo-West Pacific and ten from the north-western and western Atlantic and eastern Pacific Oceans. Here, we add three species described originally from the Indo-West Pacific to the Australian fauna, comment briefly on three

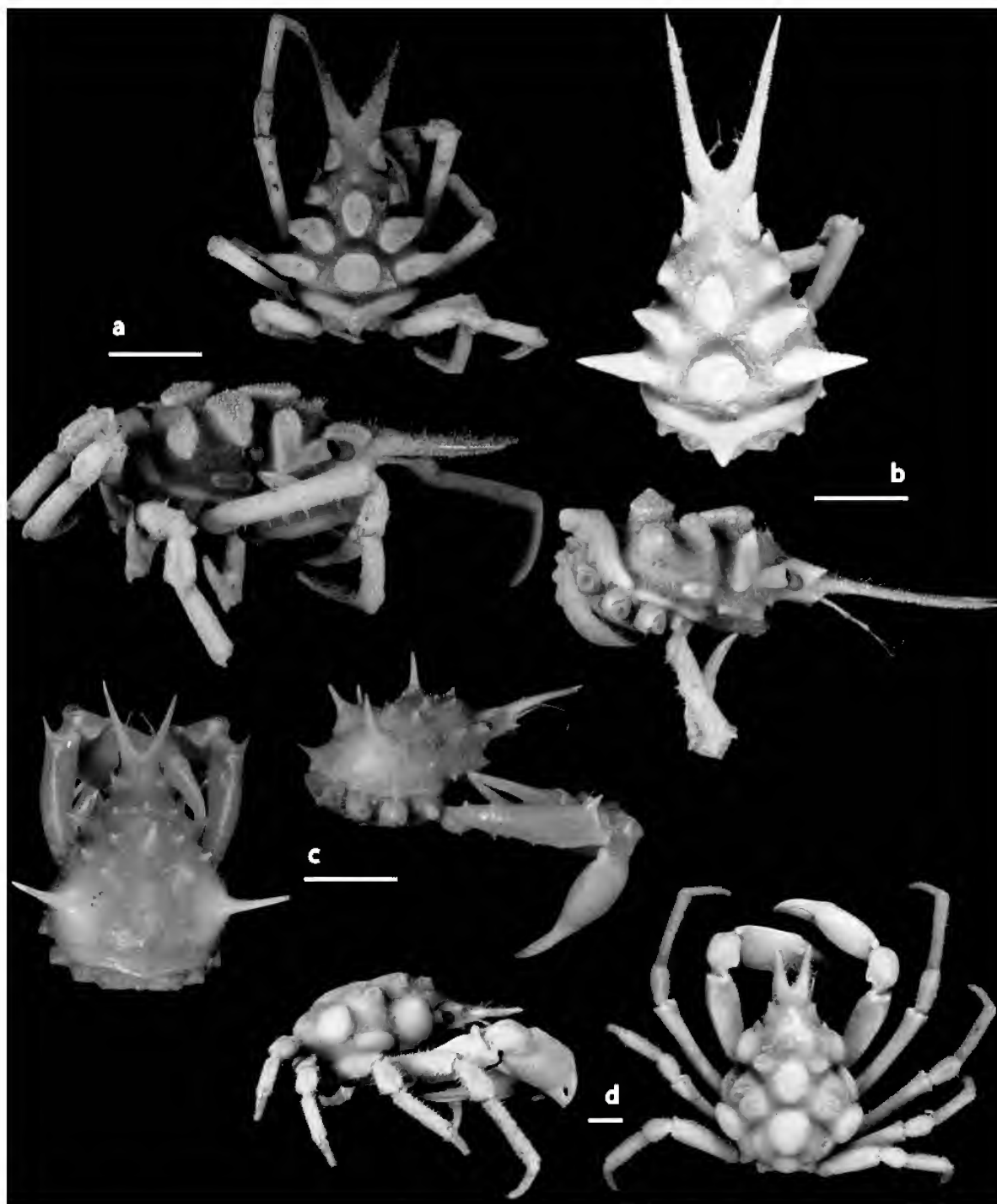


Figure 1. Lateral and dorsal views, scale = 5 mm. a, *Oxypleurodon luzonicum* (female, NMV J58221). b, *Oxypleurodon wilsoni* sp. nov. (holotype, WAM C400259). c, *Rochinia annae* sp. nov. (holotype, WAM C400531). d, *Rochinia carinata* (male, NMV J53872).

others, and describe a new species from Western Australia.

***Rochinia annae* sp. nov.**

Figures 1c, 3

Rochinia sp. MoV5119.—Poore et al., 2008: 56.

Rochinia fultoni.—Poore et al., 2008: 56 (colour fig.).

Material examined. Holotype: Australia, WA. Off Two Rocks (31°37.05'S–31°37.23'S, 114°58.19'E–115°14.39'E), 364–404 m, 19 Nov 2005 (SS10/2005 004), WAM C400531 (male, 11.9 x 8.6 mm).

Paratypes. Same data as holotype. WAM C400532 (11 specimens), NMV J54179 (87 specimens, smallest is a male of 7.3 x 4.6 mm).

Other material. Australia. WA. Off Kalbarri (27°55.43'S–27°56.01'S, 113°08.17'E–113°08.38'E), 252–253 m, 04 Dec 2005 (stn SS10/2005 099), NMV J54058 (1 male). Off Two Rocks (31°36.32'S–31°37.02'S, 114°58.52'E–114°58.16'E), 329–370 m, 19 Nov 2005 (stn SS10/2005 006), NMV J54178 (2 ovigerous females 10.5 x 8.2 mm, 8.6 x 6.9 mm). Jurien Bay (29°52.04'S–29°52.26'S, 114°23.13'E–114°23.53'E), 414–401 m, 02 Dec 2005 (stn SS10/2005 078), NMV J54253 (7 juveniles). Off Lancelin (31°00.45'S–31°00.17'S, 114°49.30'E–114°49.23'E), 394–393 m, 01 Dec 2005 (stn SS10/2005 075), NMV J54238 (1 male). Off Bunbury (33°00.30'S–33°00.07'S, 114°34.16'E–114°34.30'E), 421–414 m, 20 Nov 2005 (stn SS10/2005 013), NMV J54073 (male 8.3 x 5.7 mm), J54238 (1 female 6.0 x 4.6 mm). Off D'Entrecasteaux (35°04.11'S–35°04.14'S, 115°20.10'E–115°20.53'E), 378–379 m, 21 Nov 2005 (stn SS10/2005 017), NMV J54916 (1 male 9.5 x 10.7 mm, 2 ovigerous females 8.4 x 6.1 mm, 10.5 x 7.4 mm, 2 females 7.6 x 4.7 mm, 7.2 x 5.2 mm).

Diagnosis. Carapace to 11.9 mm long, pyriform with long diverging pseudorostral spines (one-third length of carapace). Dorsal surface spiny, longest spines as follows: 2 longest and thin branchial spines twice as long as other spines; 1 intestinal spine; 1 long cardiac spine; 1 long mesogastric spine; 2 hepatic spines; in protogastric area, a line of 3 short blunt spines, 2 other spines alongside mesogastric spine; 2 short spines on epigastric area; 2 short spines on lower side of cardiac area.

Cheliped of male short with chelae inflated; merus cylindrical, smooth, with 5 blunt teeth on inferior border, upper anterior angle forming 2 teeth; carpus short and triangular, forming a carina at its interior border; propodus inflated and carinate on upper border; fingers thin with serrulated interior border; dactylus border forming a bump in its first third. Ambulatory legs long and thin; articles cylindrical, pereopod 2 longer than pereopod 1 (pereopod 2 merus reaching little beyond ridge on reflexed carpus of pereopod 1).

Eyes small, protected by cupped postocular tooth; large supraocular tooth. Basal antennal article with long tooth on its antero-external angle; article fused to carapace. Antenna flagellum longer than pseudorostrum; antennule fossae sharp anteriorly. Border of buccal frame expanded laterally. Abdomen of 7 segments. Pleopod 1 of pisid type, distally expanded to an oblique truncate spinose margin, 16 setae in groove (fig. 3).

Distribution. South-western WA slope (27°–35°S), 252–424 m depth.

Etymology. The species is named in honour of Anna McCallum, who sorted and made preliminary identifications of many of

the Decapoda of the Western Australian cruises.

Remarks. Of the 35 species described in the genus *Rochinia* few have long branchial spines. The only species comparable to *R. annae* sp. nov. are: *R. pulchra* (Miers, 1886), *R. riversandersoni* (Alcock, 1895), *R. sibogae* Griffin and Tranter, 1986, *R. galathea* Griffin and Tranter, 1986, *R. griffini* Davie and Short, 1989, and *R. paulayi* Ng and Richer de Forges, 2007. *R. galathea* has a long branchial spine but a long and flat hepatic spine, very different from the spine of *R. annae*. *R. sibogae* has two very long branchial spines pointing laterally but two other long spines, one intestinal and one cardiac (one long gastric spine in *R. annae*). Also, the postocular tooth is distinct from the hepatic spine in *R. annae* whereas it is a fused plate in *R. sibogae*. *R. pulchra* has long branchial spines but a different pattern in the other long spines of the carapace: four spines in the median line (three in *R. annae*). *R. pulchra* possesses pseudorostral spines about three-quarters as long as the carapace but these are one third as long in *R. annae*. *R. riversandersoni* is a large species with long branchial spines and long epibranchial spines. *R. annae* has only a granule at this place. *R. paulayi* and *R. griffini* are also large species, very spiny and showing a totally different arrangement of spines from that in *R. annae*.

Although there is abundant material no specimen is intact and it is not possible to be precise about the relative lengths of pereopods.

The species occurs over a wide geographic range along the south-western WA coast.

***Rochinia carinata* Griffin and Tranter, 1986**

Figure 1d

Rochinia carinata Griffin and Tranter, 1986a: 178, figs 56, 64e, f, pl. 12.—Ng and Richer de Forges, 2007: 62.

Rochinia sp. MoV 5136.—Poore et al., 2008: 56.

Material examined. Australia. WA. Off Barrow Island (21°00.24'S–21°00.02'S, 114°22.52'E–114°22.30'E), 399–408 m, 13 Dec 2005 (stn SS10/2005 172), NMV J53872 (1 male 28.2 x 20.7 mm). Off Ningaloo North (21°58.13'S–21°58.45'S, 113°47.35'E–113°47.28'E), 356–324 m, 11 Dec 2005 (stn SS10/2005 157), NMV J53873 (1 female juvenile 14.2 x 9.9 mm). Off Red Bluff (23°59.12'S–23°59.43'S, 112°32.02'E–112°31.44'E), 411 m, 08 Dec 2005 (stn SS10/2005 130), NMV J54067 (1 juvenile 10.5 x 6.5 mm).

Remarks. *Rochinia carinata* was described from the Kei (Kai) Islands in Indonesia and has not been recorded anywhere else since. The specimens from the south-western Australian coast differ from the typical material from Indonesia (Griffin and Tranter, 1986a: pl. 12). The merus of pereopods 2 and 3 is cylindrical in cross section vs carinate in the Indonesian specimens. The mesogastric plate (islet) looks more ovoid in *R. carinata* from Western Australia whereas it is more rounded in the typical material. The pseudorostrum spines are more elongated in the specimens from south-western Australia than in the specimens from Indonesia.

The species' range is extended from 5°S in Indonesia to 24°S, near Shark Bay, WA. The depth range in Indonesia is 204–325 m and 324–411 m in WA.

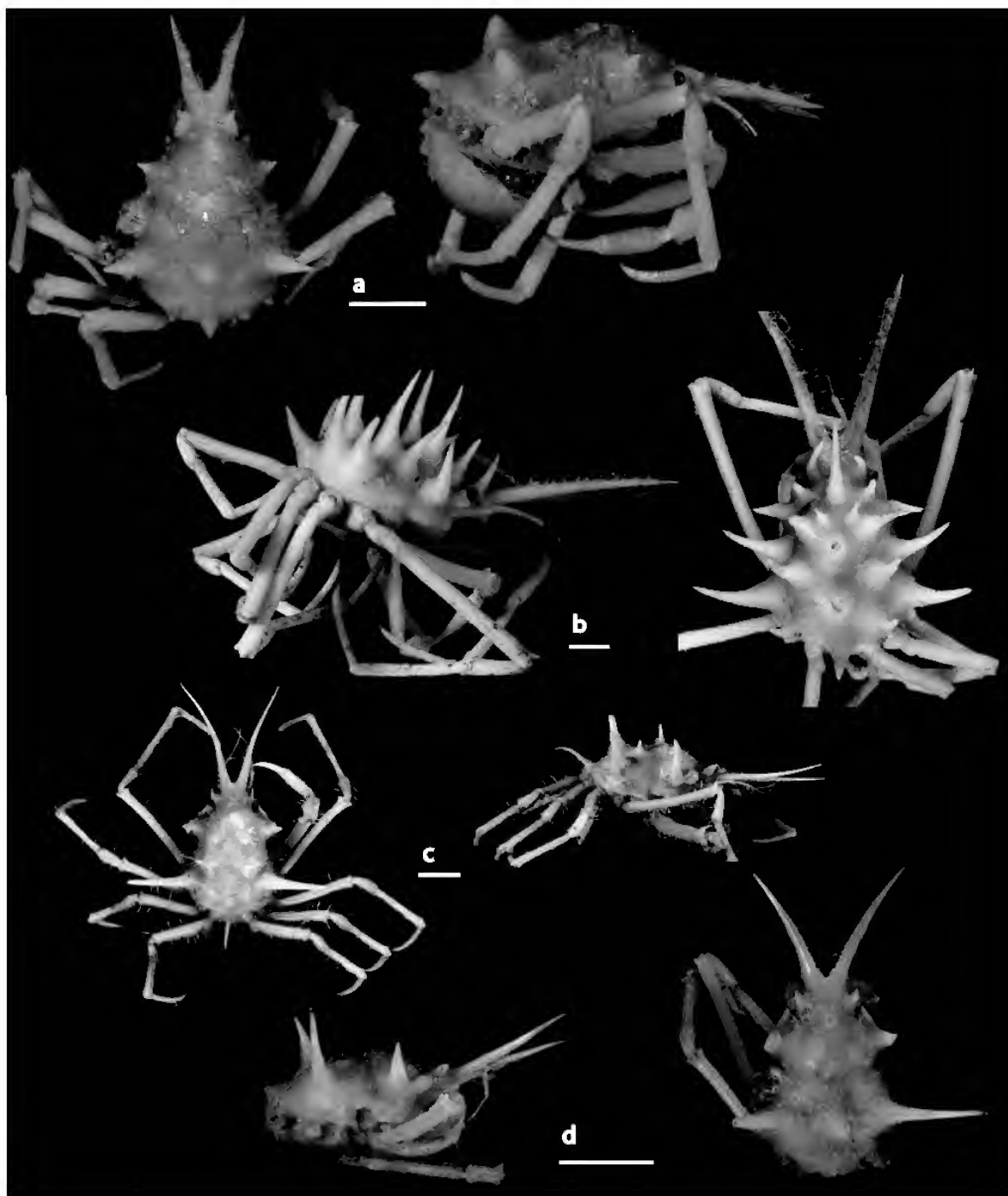


Figure 2. Lateral and dorsal views, scale = 5 mm. a, *Rochinia fultoni* (female, NMV J4730). b, *Rochinia pulchra* (female, NMV J55947). c, *Rochinia sibogae* (male, NMV J58142). d, *Rochinia strangeri* (female, NMV J55427).

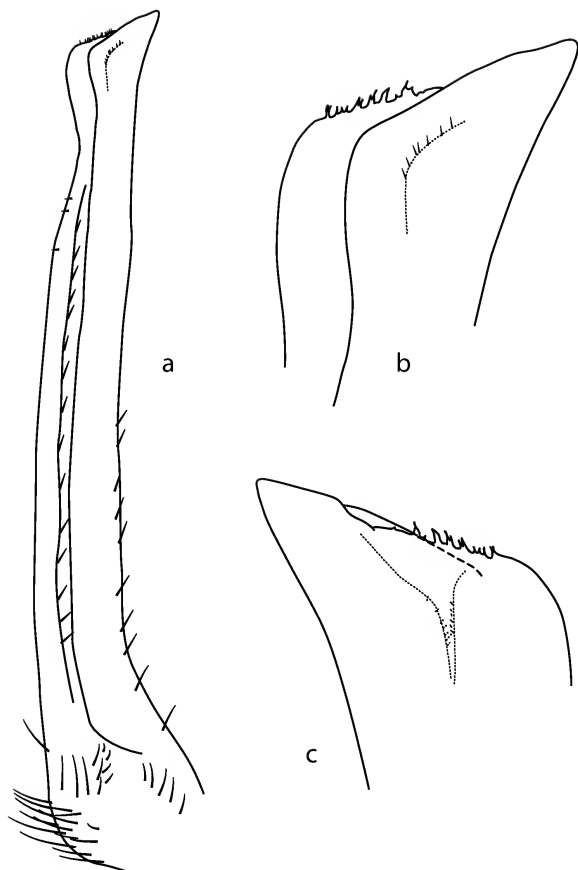


Figure 3. *Rochinia annae* sp. nov. Male left pleopod I (paratype WAM C400531). a, anterior view. b, detail of tip, anterior view. c, detail of tip, posterior view.

Rochinia fultoni (Grant, 1905)

Figure 2a

Hyastenus fultoni Grant, 1905: 313, pl. 11 fig. 1.

Rochinia fultoni.—Griffin, 1966: 280.—Griffin and Tranter, 1986a: 176.—Poore, 2004: 387, fig. 118f.—Ng and Richer de Forges, 2007: 62.

Material examined. Australia. Tas. Eastern Bass Strait, 100 km NE of North Point, Flinders I., (38°52.36'S, 148°25.12'E), 140 m, 15 Nov 1981 (stn BSS 170 S), NMV J4730 (2 ovigerous females 15.0 x 10.0 mm, 11.3 x 7.5 mm; male 11.7 x 7.0 mm). 70 km ENE of North Point, Flinders I. (39°28.24'S, 148°41.48'E), 110 m, 28 Mar 1979 (stn BSS 35), NMV J23091 (juvenile). 37 km NE of Cape Tourville (41°52.52'S–41°59.34'S, 148°37.56'E–148°31' 08'E), 124 m, 30 Oct 1988 (stn SLOPE 85), NMV J16059 (male). Vic. W of Cape Nelson, 183 m, 06 Jun 1969, NMV J8610 (male, ovigerous female)

Remarks. This species has already been mentioned from the east and south coasts of Australia. Most records in Museum

Victoria are from the continental margin of eastern Bass Strait.

Rochinia mosaica (Whitelegge, 1900)

Pugettia mosaica Whitelegge, 1900: 141, pl. 35 figs 5–7.

Doclea profunda Rathbun, 1918: 16, pl. 7 figs 1, 2.—Hale, 1927: 134, fig. 134.

Rochinia mosaica.—Griffin and Tranter, 1986a: 185, figs 58, 62e, f.—Griffin and Tranter, 1986b: 363.—Poore, 2004: 387.—Ng and Richer de Forges, 2007: 62.

Material examined. Australia. Tas. Eastern Bass Strait, 100 km NE of North Point, Flinders I. (38°52.36'S, 148°25.12'E), 140 m, 15 Nov 1981 (stn BSS 170 S), NMV J4731 (female 9.3 x 6.6 mm). Vic. Eastern Bass Strait, S of Waratah Bay (38°59.54'S, 146°00'E), 64 m, 26 Nov 1973 (stn K7-73-63), NMV J12157 (2 males 13.2 x 9.4 mm, 12.7 x 8.7 mm). Central Bass Strait, 100 km SSE of Cape Liptrap (39°45.54'S, 145°33.18'E), 74 m, 13 Nov 1981 (stn BSS 156), NMV J10642 (juvenile); NMV J4732 (female 8.1 x 5.1 mm). SA. Great Australian Bight (33°15.52'S–33°16.03'S, 130°37.50'E–130°37' 07'E), 139–141 m, 09 May 2000 (stn SS01/00 334), NMV J52198 (3 males 8.5 x 5.2 mm, 7.3 x 4.8 mm, 7.2 x 4.3 mm). Great Australian Bight (33°16.00'S–33°16.36'S, 130°43.09'E–130°48.38'E), 134–130 m, 10 May 2000 (stn SS01/00 351), NMV J52196 (2 ovigerous females 11.3 x 7.7 mm, 10.9 x 7.4 mm). Great Australian Bight (33°16.00'S–33°16.01'S, 130°36.35'E–130°38.02'E), 143–140 m, 10 May 2000 (stn SS01/00 350), NMV J52197 (3 males 9.1 x 5.8 mm, 9.4 x 5.9 mm, 7.7 x 4.5 mm; ovigerous female 9.1 x 5.7 mm; female 7.1 x 4.5 mm; juvenile 4.8 x 3.3 mm).

Remarks. This material from south-eastern Australia fits well with the redescription of *R. mosaica* by Griffin and Tranter (1986a). Whitelegge described this species in the genus *Pugettia* in which the carapace has a similar pattern but the first pleopod of *Pugettia* is very different from that of *Rochinia*. The records are well within the reported distribution of the species from central Queensland, through Bass Strait to the Great Australian Bight. The most westerly is 130°W near the SA–WA border.

Rochinia pulchra (Miers, 1886)

Figure 2b

Anamathia pulchra Miers, 1886: 26, pl. 4 figs 1a–c.

Scyramathia pulchra.—Alcock, 1895: 202.—Doflein, 1904: 84, pl. 27 fig. 12.

Rochinia pulchra.—Sakai, 1938: 278, fig. 35, pl. 37 fig. 4.—Sakai, 1976: 223, pl. 79 fig. 1.—Serène and Lohavanijaya, 1973: 56, figs 119–122, pl. 11A.—Takeda and Kurata, 1977: 144, fig. 4a, b.—Griffin, 1976: 210.—Griffin and Tranter, 1986b: 363.—Davie and Short, 1989: 181.—Ng and Richer de Forges, 2007: 62.

Not *Rochinia pulchra*.—Griffin and Tranter, 1986a: 187 (part, NSW specimen) (= *Rochinia griffini* Davie and Short, 1989)

Material examined. Australia. WA. Ashmore L30 transect (12°31.46'S–12°30.50'S, 123°25.38'E–123°25.22'E), 401–404 m, 07 Jul 2007 (stn SS05/2007 192), NMV J58172 (female 17.3 x 10.7 mm). Kulumburu L29 transect (13°15.54'S–13°16.21'S, 123°22.27'E–123°21.24'E), 394–390 m, 07 Jul 2007 (stn SS05/2007 180), NMV J58025 (female 31.5 x 20.1, male 34.5 x 21.7 mm). Leveque L27 transect (14°49.02'S–14°48.32'S, 121°27.33'E–121°29.34'E), 407–392 m, 27 Jun 2007 (stn SS05/2007 107), NMV J55947 (female 23.3 x 16.6 mm). Leveque L27 transect (14°51.12'S–14°50.43'S,

121°25.53'E–121°27.01'E), 403–396 m, 03 Jul 2007 (stn SS05/2007 144), NMV J58220 (ovigerous female 28.7 x 21.9 mm). Lacepede L26 transect (15°47.34'S–15°48.30'S, 121°03.30'E–121°02.53'E), 119–111 m, 01 Jul 2007 (stn SS05/2007 129), NMV J55681 (male 12.9 x 10.2 mm).

Remarks. This species, characterised by its very long and numerous spines, has already been recorded from the north-west slope of Australia. The other records are from Japan to the Philippines. All these specimens are from extreme north WA. Griffin and Tranter (1986a) tentatively identified a female from NSW as this species but it was described as *Rochinia griffini* Davie and Short, 1989.

Rochinia sibogae Griffin and Tranter, 1986

Figure 2c

Rochinia sibogae Griffin and Tranter, 1986b: 363, fig. 12.

Rochinia riversandersoni.—Griffin, 1976: 211.—Griffin and Tranter, 1986a: 187.—Davie and Short, 1989: 181.—Ng and Richer de Forges, 2007: 62.

Material examined. WA. Mermaid L24 transect (16°38.04'S–16°38.46'S, 119°09.13'E–119°08.02'E), 990–987 m, 17 Jun 2007 (stn SS05/2007 068), NMV J58024 (ovigerous female 16.2 x 10.6 mm). Barrow L1 transect (20°57.09'S–20°57.34'S, 114°00.47'E–114°00.26'E), 1000 m, 09 Jun 2007 (stn SS05/2007 002), NMV J58142 (male 18.4 x 12.6 mm).

Remarks. This species was described by Griffin and Tranter (1986b) from specimens from Ceram Island, Indonesia. The authors drew attention to the common confusion between *R. sibogae* and *R. riversandersoni* (Alcock, 1895) from India. They gave a short key to species of this group of *Rochinia* where *R. sibogae* is clearly separated from the others by the hepatic plate fused with the postocular plate. This new locality for *R. sibogae* extends the range of the species far south of Indonesia, from 3°S to 20°S on the north-west slope at 1000 m, a similar depth to the type locality.

Rochinia strangeri Serène and Lohavanijaya, 1973

Figure 2d

Rochinia strangeri Serène and Lohavanijaya, 1973: 57, figs 123–128, pl. 11B, C.—Griffin and Tranter, 1986a: 175 (key).—Ng and Richer de Forges, 2007: 62.—Poore et al., 2008: 56.

Rochinia aff. *strangeri*.—Serène and Vadon, 1981: 128, pl. 4D.

Material examined. Australia. WA. Abrolhos (29°03.39'S, 29°04.41'S, 113°38.10'E–113°37.48'E), 1000–1037 m, 02 Dec 2005 (stn SS10/2005 084), NMV J55427 (ovigerous female 11.0 x 6.8 mm).

Remarks. This species was described by Serène and Lohavanijaya (1973) from only two specimens from the South China Sea. The closest species is *R. riversandersoni* (Alcock, 1895) from India. Serène and Vadon (1981), in a preliminary list of Brachyura from the MUSORSTOM collection in the Philippines, mentioned a specimen as *Rochinia* aff. *strangeri*. The photograph of this specimen looks very similar to the specimen from south-western Australia (29°S).

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References

- Alcock, A. 1895. Materials for a carcinological fauna of India. No. 1. The Brachyura Oxyrhyncha. *Journal of the Asiatic Society of Bengal* 64: 157–291, pls 153–155.
- Davie, P.J.F. 2002. *Crustacea: Malacostraca: Eucarida (Part 2): Decapoda - Anomura, Brachyura*. Vol. 19.3B. CSIRO Publishing: Melbourne. xiv, 641 pp.
- Davie, P.J.F., and Short, J.W. 1989. Deepwater Brachyura (Crustacea: Decapoda) from southern Queensland, Australia with descriptions of four new species. *Memoirs of the Queensland Museum* 27: 157–87.
- Doflein, F. 1904. Brachyura. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer “Valdivia” 1898–1899* 6: 1–314, pls 311–58.
- Estampador, P. 1937. A check list of Philippine crustacean decapods. *Philippine Journal of Science* 62: 465–559.
- Estampador, P. 1959. Revised check list of Philippine crustacean decapods. *National Applied Science Bulletin, University of the Philippines* 17: 1–127.
- Grant, F.E. 1905. Crustacea dredged off Port Jackson in deep water. *Proceedings of the Linnean Society of New South Wales* 1905: 312–24, pls 310–11.
- Griffin, D.J.G. 1966. A review of the Australian majid spider crabs (Crustacea, Brachyura). *Australian Zoologist* 13: 259–298, pls 215–217.
- Griffin, D.J.G. 1976. Spider crabs of the family Majidae (Crustacea: Brachyura) from the Philippine Islands. *Journal of Natural History* 10: 179–222.
- Griffin, D.J.G., and Tranter, H.A. 1986a. The Decapoda Brachyura of the Siboga Expedition. Part VIII Majidae. *Siboga Expédition* 39: 1–335.
- Griffin, D.J.G., and Tranter, H.A. 1986b. Some majid spider crabs from the deep Indo-West Pacific. *Records of the Australian Museum* 38: 351–71.
- Guinot, D., and Richer de Forges, B. 1986a. Crustacés Décapodes : Majidae (genres *Platymaia*, *Cyrtomaia*, *Pleistacantha*, *Sphenocarcinus* et *Naxioides*). In: *Résultats des Campagnes MUSORSTOM 1 and 2. Mémoires du Muséum National d'Histoire Naturelle, Paris, ser. A (Zoologie)* 133: 83–178.
- Guinot, D., and Richer de Forges, B. 1986b. Découverte d'une nouvelle espèce de *Sphenocarcinus* en Nouvelle-Calédonie, *S. mammatum* sp. nov. (Crustacea, Decapoda, Brachyura). *Indo-Malayan Zoology* 3: 27–37.
- Hale, H.M. 1927. *The crustaceans of South Australia. Part 1*. South Australian Government Printer: Adelaide. 201 pp.

- MacLeay, W.S. 1838. On the brachyurous decapod Crustacea brought from the Cape by Dr Smith. Pp. 53–71. In: Smith, A. (ed.) *Illustrations of the Annulosa of South Africa, Illustrations of the Zoology of South Africa*. Smith, Elder and Co.: London.
- Miers, E.J. 1886. Report on the Brachyura collected by H.M.S. *Challenger* during the years 1873–76. *Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873–76*. Zoology 17: 1–362, pls 361–329.
- Milne-Edwards, A. 1875. Études sur les Xiphosures et les Crustacés podophthalmes. Pp. 1–368, pls 361–361 in: *Mission scientifique au Mexique et dans l’Amérique centrale. Recherches Zoologiques pour servir à l’histoire de la faune de l’Amérique centrale et du Mexique. Part 5*. Imprimerie Nationale: Paris.
- Ng, P.K.L., and Richer de Forges, B. 2007. A new species of deep-water spider crab of the genus *Rochinia* A. Milne-Edwards, 1875, from Guam (Crustacea: Brachyura: Majidae). *Zootaxa* 1610: 61–68.
- Ng, P.K.L., Guinot, D., and Davie, P.J.F. 2008. Systema Brachyurorum; Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bulletin of Zoology* 17: 1–286.
- Poore, G.C.B. 2004. *Marine decapod Crustacea of southern Australia. A guide to identification (with chapter on Stomatopoda by Shane Ahyong)*. CSIRO Publishing: Melbourne. 574 pp.
- Poore, G.C.B., McCallum, A.W., and Taylor, J. 2008. Decapod Crustacea of the continental margin of south-western and central Western Australia: preliminary identifications of 524 species from FRV *Southern Surveyor* voyage SS10-2005. *Museum Victoria Science Reports* 11: 1–106.
- Rathbun, M.J. 1916. Scientific results of the Philippine cruise of the Fisheries Steamer ‘Albatross’, 1907–1910. No. 34. New species of crabs of the families Inachidae and Parthenopidae. *Proceedings of the United States National Museum* 50: 527–59.
- Rathbun, M.J. 1918. Report on the spider crabs obtained by the F.I.S. ‘*Endeavour*’ on the coasts of Queensland, New South Wales, Victoria, South Australia and Tasmania. *Biological Results of the Fishing Experiments carried out by the F.I.S. ‘Endeavour’, 1909–14* 5: 1–29, pls 21–15.
- Richer de Forges, B. 1992. A new species of *Sphenocarcinus* A. Milne Edwards, 1875 from Tasmanian guyots, *S. lowryi* n. sp. (Crustacea, Decapoda, Brachyura). *Records of the Australian Museum* 44: 1–5.
- Richer de Forges, B. 1995. New findings and new species of deep-sea majids of the genus *Oxypleurodon* Miers, 1886. *Crustaceana* 68: 43–60.
- Sakai, T. 1938. *Studies on the crabs of Japan. 3. Brachygnatha Oxyrhyncha*. Yokendo: Tokyo. 193–364, pls 120–141.
- Sakai, T. 1976. *Crabs of Japan and adjacent seas*. Kodansha Ltd: Tokyo. 773 pp. plus volume of 251 plates.
- Serène, R., and Lohavanijaya, P. 1973. The Brachyura (Crustacea: Decapoda) collected by the Naga Expedition, including a review of the Homolidae. *Naga Report. Scientific Results of Marine Investigations of the South China Sea and the Gulf of Thailand* 4: 1–186, 186 figs, 121 pls.
- Serène, R., and Vadon, C. 1981. Crustacés Décapodes: Brachyours. Liste préliminaire, description de formes nouvelles et remarques taxonomiques. Pp. 117–140 in *Résultats des Campagnes MUSORSTOM. I. Philippines (18–28 mars 1976)*. Vol. 1. ORSTOM – Muséum National d’Histoire Naturelle: Paris.
- Takeda, M., and Kurata, Y. 1977. Crabs of the Ogasawara Islands IV. A collection made of the new volcanic island, Nishino-shima-shinto, in 1975. *Bulletin of the National Science Museum, Tokyo, Ser. A (Zoology)* 3: 91–111.
- Tavares, M. 1991. Rédefinition des genres *Rochinia* A. Milne-Edwards, *Sphenocarcinus* A. Milne-Edwards et *Oxypleurodon* Miers, et établissement du genre *Nasutocarcinus* gen. nov. (Crustacea, Brachyura, Majidae). *Bulletin du Muséum National d’Histoire Naturelle, Paris* 13: 159–179.
- Webber, W.R., and Richer de Forges, B. 1995. Deep sea Majidae (Decapoda: Brachyura) new to New Zealand with a description of *Oxypleurodon wanganella* sp. nov. *Journal of the Royal Society of New Zealand* 25: 501–516.
- Whitelegge, T. 1900. Scientific results of the trawling expedition of H.M.C.S. ‘*Thetis*’ off the coast of New South Wales in February and March, 1898. Crustacea. Part I. *Memoirs of the Australian Museum* 4: 135–199, pls 132–135.

The Psocoptera (Insecta) of Tasmania, Australia

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Abstract

Schmidt, E.R. and New, T.R. 2008. The Psocoptera (Insecta) of Tasmania, Australia. *Memoirs of Museum Victoria* 65: 71–152.

A systematic synopsis of the Psocoptera of Tasmania, Australia, based on extensive specialist collecting and review of all available material totalling 109 species, including representatives of 15 families. A checklist of species and keys to all taxa are provided. Six new genera (*Bassocaecilius* gen. nov., *Clinocaecilius* gen. nov., *Graminacaecilius* gen. nov., *Nothocaecilius* gen. nov., *Tasmanocaecilius* gen. nov. – all Caeciliusidae; *Abelopsocus* gen. nov. – Philotarsidae) and 30 new species from nine families are described and illustrated, and their affinities discussed. They are: *Lepinotus huoni* sp. nov. (Trogidae), *Embidopsocus lenah* sp. nov. (Liposcelididae), *Bassocaecilius rawlinsoni* sp. nov., *Clinopsocus edwardsi* sp. nov., *Maoripsocus hobartensis* sp. nov., *M. pedderi* sp. nov., *M. spiralosus* sp. nov., *M. tahunensis* sp. nov., *M. wedgei* sp. nov., *M. weindorferi* sp. nov., *Graminacaecilius frontalis* sp. nov., *G. micropterus* sp. nov., *Nothocaecilius thomasi* sp. nov., *Tasmanocaecilius truchanasi* sp. nov. (Caeciliusidae), *Ectopsocus coyae* sp. nov., *E. graminus* sp. nov., *E. hickmani* sp. nov., *E. risdonensis* sp. nov., *E. sprengi* sp. nov. (Ectopsocidae), *Peripsocus cochleus* sp. nov., *P. pamae* sp. nov. (Peripsocidae), *Howeanum tasmaniensis* sp. nov. (Pseudocaeciliidae), *Abelopsocus truganinae* sp. nov., *Philotarsopsis hellyeri* sp. nov. (Philotarsidae), *Propsoocus frodshami* sp. nov. (Elipsocidae), *Ptycta colei* sp. nov., *P. freycineti* sp. nov., *P. pallawahensis* sp. nov., *Tanystigma maddeni* sp. nov., *T. westae* sp. nov. (Psocidae).

Keywords

Australia, new taxa, Caeciliusidae, Philotarsidae

Introduction

The insect order Psocoptera occurs commonly in all zoogeographic regions (Lienhard and Smithers, 2002). Several species are cosmopolitan and others have wide tropical ranges. Many species, however, have limited distributions, giving rise to characteristic regional faunas. Approximately 300 species are known from Australia (Smithers, 1996a). This number is likely to be a considerable underestimate of the total fauna because large areas, particularly in northern and Western Australia, have not been surveyed by specialists and Psocoptera are not collected routinely by most other entomologists.

Southeastern Australia has been explored more effectively. Surveys of Muogamarra Nature Reserve, near Sydney (Smithers, 1977) and Tuglo Wildlife Refuge, Hunter Valley, New South Wales (Smithers, 1993, 1994b, 1996b, 1996d, 1997), South Australia (Smithers, 1984, 1998), The Grampians and Mt Arapiles, Victoria (Endersby et al., 1990), and Wilsons Promontory, Victoria (Schmidt and Thornton, 1993) indicate that the temperate Australian psocopteran fauna is reasonably diverse. The Wilsons Promontory survey and those of the Otway Ranges (Thomas, 1986) and some Bass Strait islands (Cole et al., 1989) have considerably augmented our knowledge of the psocopteran fauna of the Bass Strait region. Though

limited in scope, most of these surveys have provided some information on vegetation preferences and phenological traits of particular species. Until now 96 species have been recorded from Victoria but other, undescribed species are known.

Tasmania and the Bass Strait region are well suited for the investigation of patterns of distribution and evolution of Psocoptera and the plants with which they are associated. Global changes in climate have exposed land bridges between mainland Australia and Tasmania on numerous occasions since the Miocene, and have considerably altered the range and dominance of particular vegetation communities. The emergence of fire-prone sclerophyllous plant communities and the intermittent land connections and associated vegetation shifts have repeatedly isolated and fused habitats in processes conducive to speciation.

This paper is a systematic account of the Psocoptera of Tasmania. It provides, for the first time, a reasonably complete synopsis of the taxa present and their distributions based on substantial specialist collecting. One hundred and nine species, representing 15 families, are included. Only 31 species of Psocoptera (excluding the name *Liposcelis divinatorius* Müller) have been recorded previously from Tasmania, mainly by Hickman (1934), Edwards (1950) and Smithers (1979), and the

occasional records of Smithers (1963), New (1973a), Thornton and New (1977) and Schmidt and Thornton (1993). Most of these species were recorded from the east and north coasts, and the records from the southwest were limited to the Lower Gordon River area (Smithers, 1979). Coy et al. (1993) listed the Tasmanian Psocoptera identified by ERS that were collected as part of the National Rainforest Conservation Project. Smithers (1996a) listed 49 species for Tasmania, but this figure includes the Bass Strait island fauna. The islands are politically under the control of Tasmania but biogeographically can be treated separately. Schmidt and New (2004b) gave a preliminary outline of the biogeography of the Tasmanian Psocoptera.

Site Area

Tasmania lies south of the southeastern corner of the Australian mainland (fig. 1), separated from it by Bass Strait, which is approximately 240 km wide. It extends from 40°38' to 43°39' south latitude and from 144°36' to 148°23' east longitude (296 km from north to south, 315 km east to west). On the south and west the coastline is bounded by the Southern Ocean and on the east by the Tasman Sea. With an area of 64,409 square kilometres, Tasmania represents about 0.9% of the total area of Australia.

While mainland Australia is basically a warm, dry continent, Tasmania is classified as temperate maritime. Being south of 40° latitude it is on the edge of the wind belts of prevailing westerlies (commonly known as the Roaring Forties). This is the dominant factor producing the climate on the island (Langford, 1965). The insular position of Tasmania and the stabilising effect of the surrounding oceans provide protection against temperature extremes, so that variation between summer and winter mean temperatures in coastal towns rarely exceeds 8°C, rising to about 12°C further inland, indicating a slight continental effect.

Compared with other states, Tasmania has the largest proportion of high country. The mountains are not very high – few exceed 1500 metres – but are very numerous, particularly in the western half of the state. The combination of mountainous terrain in western Tasmania and prevailing westerly winds produces a marked west–east gradient in rainfall. Westerly winds are strongest and most persistent in winter, causing greatest rainfall distribution in the west and northwest. In the west the average annual rainfall ranges from about 1500 mm on the coast to 3500 mm at Lake Margaret (ten km north of Queenstown); and in the northwest from 1000 mm near the coast to 1600 mm in the higher inland areas. Rainfall in the

east and southeast is more evenly distributed throughout the year. In the northeast, rainfall ranges from 500 mm on the coast to 1300 mm on the highlands. A distinct rain shadow occurs east of the Central Plateau (Great Lake region), so that parts of the Midlands (plain south of Launceston) average less than 500 mm per year. Totals in the east and southeast are higher, averaging over 800 mm on some exposed slopes.

Snow and hail can fall on the highlands at any time of the year, but generally the heaviest snowfalls occur in late winter and spring. There is no permanent snowline, but patches of snow often remain on the highest peaks until December.

Very little of the Tasmanian surface lies close to sea level. The most extensive coastal plains consist of a narrow uplifted peneplain along the west coast, and an undulating lowland in the northeast. The only extensive inland plain is in the northern Midlands (south of Launceston), and has developed on soft Tertiary sediments. Davies (1965) broadly divided the mountains into fold and fault provinces. In the west of the island, mountains tend to be ridge-like and run parallel to the west coast. The basement of folded pre-Carboniferous rocks is exposed, and river systems have excavated valleys leaving ridges of hard quartz metamorphics and conglomerates. In the northeast, granite has produced some highland areas, and in other parts erosion has only just exposed the folded basement. In the centre, east and southeast the mountains tend to be plateau-like. The older rocks are covered by horizontal Permian and Triassic sediments, into which dolerite has intruded to form horizontal sheets. The resistant dolerite dominates the landscape, capping plateau-like residuals and commonly forming scarps, often with free faces (Davies, 1965). The Central Plateau is dolerite-capped, relatively undissected and bounded on the north and east by the Great Western Tiers. In the northeast of Tasmania the dolerite-capped mountain Ben Lomond is an outlier of this plateau.

The environments of Tasmania provide a wide diversity of habitats in which a mixture of Australian and Southern Oceanic floral components are found. The composition of the presently known vascular flora is shown in Table 1: some of the totals have changed a little since Brown's (1981) account, but have not been listed together since then. Thus, chapters in Reid et al. (1999) note pteridophyte species number as 102, gymnosperms as ten, and noted total native angiosperms as 1530, all these complemented by an introduced flora of around 700 species. Listing of the flora of Tasmania is updated periodically on-line, as an up-to-date summary of new discoveries and taxonomic revisions (see Buchanan, 2007).

Table 1. The native vascular plant groups of Tasmania (after Brown, 1981).

Number	Pteridophytes	Gymnosperms	Angiosperms	Total	
				Dicots	Monocots
Families	26	3	79	21	129
Genera	42	9	305	134	490
Species	95	11	891	546	1543

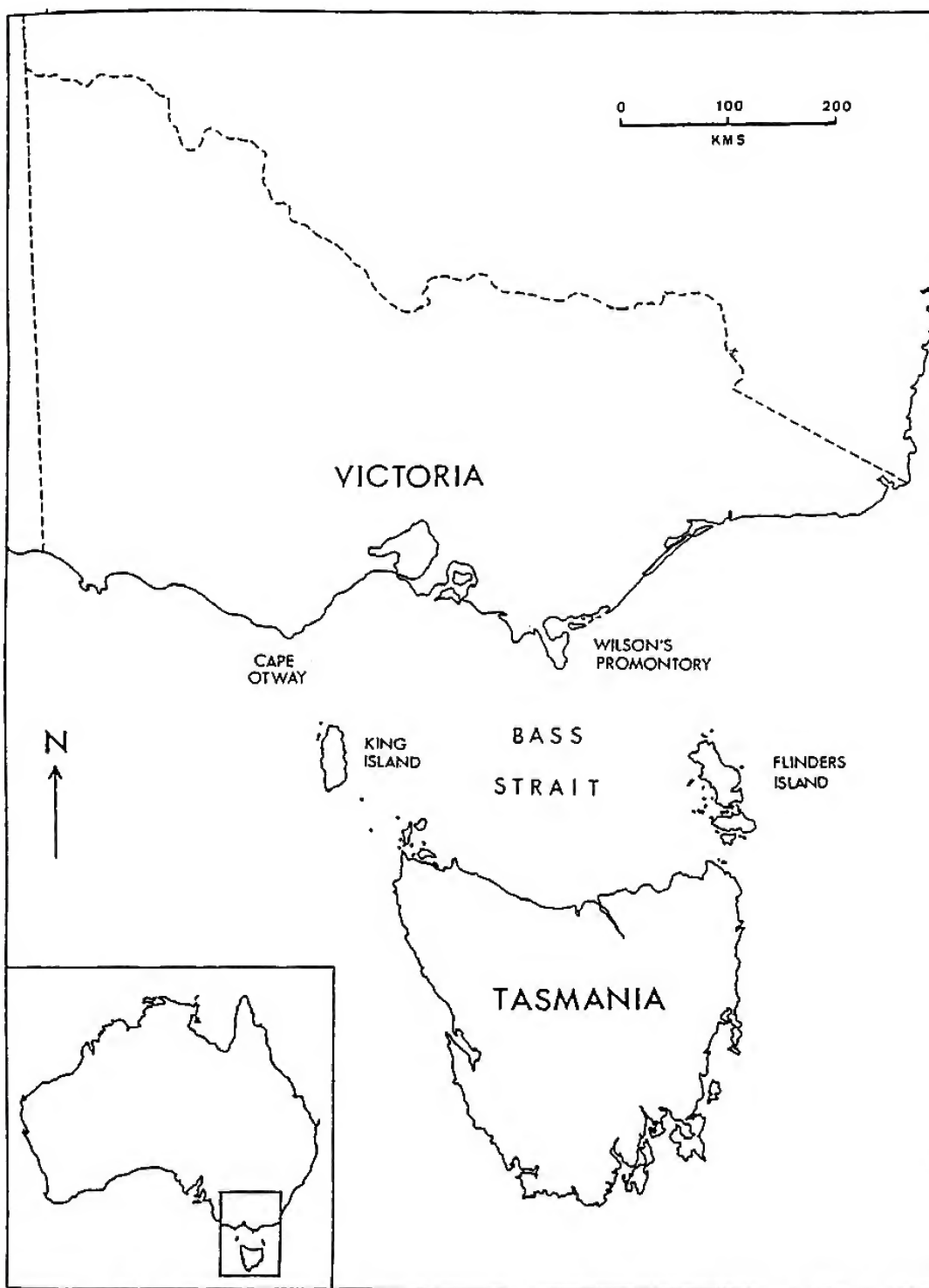


Figure 1. The Bass Strait region, showing major islands and some non-Tasmanian localities mentioned in the text.

The western region, with its high annual rainfall, has close floristic affinities with New Zealand and South America, while the drier eastern region is predominantly Australian in character. The mountainous topography, coupled with rapid changes in soil type, provides a wide range of local environments within these regions, and the vegetation varies floristically and structurally with local changes in altitude, aspect and soil type (Jackson, 1981a). Kirkpatrick and Dickinson (1984) delineated the distribution of 49 vegetation groups, which Duncan (1985) broadly divided into ten major types (five forest, five non-forest), as follows:

1. *Rainforest*. Cool temperate rainforest is defined (Jarman and Brown, 1983) as vegetation with trees greater than eight metres tall, dominated by one or more of the following genera: *Nothofagus*, *Atherosperma*, *Eucryphia*, *Phyllocladus*, *Athrotaxis*, *Lagarostrobos*, and *Anodopetalum* becoming increasingly important on poor soils. On the basis of community structure and floristics, four broad rainforest groups have been identified (Jarman et al., 1984): a) callidendrous – characterised by park-like communities with open, shady understoreys; b) thamnic – with a well developed shrub layer; c) implicate – with a dense understorey network of stems that makes upright movement through these forests difficult, and d) open montane – confined to high altitude boulder fields or rocky outcrops.

On highly fertile soils the forest is simple structurally and floristically (callidendrous), but becomes more complex on soils of low fertility (implicate). The most important climatic determinant limiting the distribution of rainforest is rainfall. Rainforest is the climax in any area with a minimum annual rainfall of 1000 mm and minimum summer monthly rainfall of 25 mm. All rainforest dominants are fire-sensitive. Jackson (1981b) considered that rainforest occupies only about a quarter of its potential habitat, with fire maintaining the presence of disclimax sclerophyll forest, scrub and moorland communities in the remaining area. Rainforest extends from sea level to about 1200 m.

2. *Mixed Forest*. Mixed forest comprises vegetation with an understorey of rainforest species and an overstorey of eucalypts, which become sparse as the forest approaches maturity. The dominance of rainforest or wet sclerophyll shrubs in the understorey depends on the frequency of fires. Lowland mixed forest is maintained by infrequent fires with an interval of 100 to 350 years, which allows the re-establishment of shade-intolerant eucalypts. If fires are too infrequent, pure rainforest develops as the over-mature eucalypts are eliminated. Eucalypts can be maintained in the absence of fire in open montane mixed forests.

3. *Blackwood Swamp Forest*. These forests occur mainly in the far northwestern part of the state, where they occupy slowly draining lowland flats. Closed, almost monospecific forests of *Acacia melanoxylon*, such as those now surviving in Dismal Swamp, were once widespread in the northwest but about two-thirds have been converted to pasture. Isolated blackwood swamp forests are also located in the northeast part of the state.

Scrub dominated by *Leptospermum lanigerum* and *Melaleuca ericifolia* is found in the northern part of the state on small fertile wetland areas where drainage is impeded. On

infertile siliceous sites with high water tables, scrub dominated by *Leptospermum scoparium* and *Melaleuca squarrosa* is found. These species, for the most part, form the understorey of the blackwood swamp forests.

Sclerophyll forest could be termed eucalypt forest, since eucalypts are the dominant trees. The distinction between wet and dry sclerophyll forest is structural as well as floristic (Jackson, 1981c). Wet forests are essentially two-layered, whereas dry forests tend to be multi-layered. The two are not clearly demarcated, however, and intergrade through a mosaic of different communities.

4. *Wet Sclerophyll Forest*. These forests typically have a tall dominant stratum of eucalypts, exceeding 60 m in height at maturity, and an understorey consisting of a layer of dense broad-leaved (mesophytic) shrubs, such as *Pomaderris*, *Bedfordia* and *Phebalium* (at about the 900–1000 mm isohyet). Decreasing fire frequency and increased rainfall brings conditions suitable for species such as *Olearia*, *Pittosporum*, *Atherospermum*, *Anopterus* and tree ferns, until conditions for mixed forest are reached. Kirkpatrick et al. (1988) defined 14 wet forest types from Tasmania, which included those of mixed forests (category 2 above).

5. *Dry Sclerophyll Forest and Woodland*. Dry sclerophyll communities are typified by the presence of a predominantly hard-leaved (xeric) shrub stratum, growing under a eucalypt canopy of varying density (open forest to open woodland) and a mixed (uneven) age structure. Tree ages generally correspond to past fire years. The ground layer is variable, but heaths, bracken, grass or sclerophyllous monocotyledons are the most common components (Duncan, 1981). The shrub layers are low and often sparse with a scattering of lesser trees such as *Banksia*, *Exocarpus*, *Bursaria* and *Casuarina*. In regions such as the Midlands with annual rainfalls of 500 mm and a high frequency of fires, the tree density falls almost to savanna levels with a ground cover of medium to low shrubs or *Poa* grassland. As the rainfall increases and the frequency of fires decreases, the tall shrub layer composed largely of *Acacia* and tall composites increases in density until at the 900 mm isohyet there is a transition to wet sclerophyll forest (Jackson, 1981a). Much of the land now cleared previously supported dry sclerophyll forests and woodland.

The dry sclerophyll communities of the east coast are characterised by a high degree of floral and faunal diversity (Duncan and Brown, 1985; Guiler, 1965). Duncan and Brown (1985) identified 33 communities from six main groups of dry sclerophyll forest.

6. *Dry Coastal Vegetation*. This category combines several lowland vegetation groups delineated by Kirkpatrick and Dickinson (1984), comprising *Casuarina* forest, scrub, heath and coastal grassland. Dry coastal vegetation occurs extensively on the Bass Strait islands and formerly covered much of the far northeast and northwest of Tasmania. Elsewhere its distribution is localised. Most communities have strong affinities with those occupying similar sites on the southeastern mainland, and endemism is low.

Scrub and heath are the most extensive of the dry coastal vegetation types. Heaths are concentrated on deep, leached, acid sands and skeletal siliceous soils. Infertility, drought and

waterlogging interact with high fire frequencies and the effects of salt spray in preventing much of the heath developing into scrub or woodland (Kirkpatrick, 1981). Thirty-seven communities of coastal heath have been classified based on the similarity of floristic composition (Kirkpatrick, 1977). Communities with common boundaries with heath include grassland, *Leptospermum* and *Melaleuca* scrubs, forests and woodlands of *Casuarina stricta* and mallee-form eucalypts and *Banksia serrata* (Sisters Beach only).

7. Western Moorland and Scrub. Button grass (*Gymnoschoenus*) moorland and wet scrub occurs throughout Tasmania on acid peats from sea level to over 1000 m, but is isolated in the north, east and southeast. Its greatest complexity and diversity is reached in the west and southwest, where it predominantly exists as fire-deflected disclimaxes of rainforest. In the absence of fire most moorland communities may be capable of progressing through wet scrub and sclerophyll forest to rainforest. Sclerophyllous shrubs (heaths and tea-trees of *Leptospermum*, *Melaleuca*, *Banksia marginata*, *Bauera*, *Agastachys* and *Cenarrhenes*) are widespread, but in its simplest form button grass dominates relatively homogenous sedgeland communities.

8. Alpine Vegetation. This comprises treeless high altitude vegetation, generally occurring above 1000 m, dominated by herbfield, grassland and heath communities, with emergent sclerophyllous shrubs and conifers. Most of the alpine vegetation consists of heaths of various types. In the absence of fire the climax community would be a closed heath with the conifers *Microstrobos* and *Diselma* on well drained soils, and *Podocarpus* on boulder fields. Fires have restricted these to protected localities and promoted the expansion of sclerophyllous shrubs. Bolster (cushion plants) communities are often found in a complex mosaic with bogs, dominated by sphagnum moss, and heath vegetation. Occurrences of herbfield are restricted to sites subjected to long periods of snow cover, and grasslands are generally produced by the burning of coniferous heath and bolster communities. Several alpine complexes have been delineated by Kirkpatrick and Dickinson (1984).

9. Native Grassland. Lowland grasslands were extensive in the Midlands but have been eliminated from most of their range by cultivation. Remnant grasslands are dominated by *Poa*, *Danthonia*, *Stipa* and *Themeda*. Montane grasslands are generally found on deep and fertile soils subject to severe frosts and/or cold air drainage. *Poa* dominates on well drained sites; on poorly drained sites *Danthonia* and *Microlaena* dominate.

10. Wetland and Aquatic Vegetation. This category includes communities of macrophytic vegetation dominated by aquatic or emergent species other than tall woody shrubs. Their distribution is local and dispersed. Duncan (1985) briefly summarised the composition, distribution and conservation status of this vegetation type, which includes salt marshes, saline wetlands and freshwater wetlands.

In recent years there has been a major improvement in the understanding of environments of the Tertiary epoch in Australia. From palaeontological information, Truswell (1993) described the vegetation changes in the Australian Tertiary, incorporating recent advances in the knowledge of

palaeoclimates, the Tertiary timeframe, sedimentary environments and the tectonic setting of Australia within the region. The record now available suggests a transition from widespread, very diverse rainforests in the early Tertiary to predominantly open vegetation, with rainforest restricted to wetter regions. Eocene records of *Banksia* and *Acacia* suggest that sclerophylly may have developed at this time. By the mid Miocene heath-like vegetation had become established locally in coal swamps, growing under particular fire regimes. Drier rainforests, with abundant *Araucaria*, had established first at inland localities, possibly because *Nothofagus* could not compete under more seasonal rainfall. Fire may also have led to the development of wet sclerophyll forests in the late Miocene. Grassland and savanna had become established in the Pliocene, and the expansion of eucalypts (probably at the expense of drier rainforests and Casuarinaceae woodlands) is more recent and possibly linked with human land-management practices.

Bass Strait has existed since the late Cretaceous, and from this time to the early Miocene the Bassian Rise was exposed, linking Tasmania with the mainland (at Wilsons Promontory) through the Hogan, Curtis and Kent groups of islands to Flinders and Cape Barren islands (Schmidt and Thornton, 1993: 140, Map A). King Island was linked to Tasmania in western Bass Strait, and from the early Tertiary to the early Miocene the region between King Island and the mainland (at Mornington Peninsula) was predominantly a shallow opening to a lacustrine environment (BMR Palaeogeographic Group 1990), a precursor to Lake Bass of the Pleistocene (Blom, 1988). After a major fall in sea level in the mid Oligocene, associated with the build-up of Antarctic ice, there were extensive incursions of shallow seas which isolated the Bass Strait islands from both Tasmania and the mainland in the early Miocene. Dramatic lowering of sea level in the late Miocene again exposed the Bassian Rise (except for the region adjacent to Wilsons Promontory?), which in the Pliocene was reduced to linking Flinders Island and Tasmania with the slight incursion of shallow seas. The land bridges were completely exposed again during the Pleistocene glaciations (Blom, 1988), the last peaking between 18,000 and 20,000 years ago (at which time the sea level was 132–150 m lower than today). Since then sea level has risen and the present coastline was attained about 5000 years ago.

Changes in the Australian vegetation during the Tertiary are related to the rapid northward movement of the Australian plate from Antarctica (Veevers et al., 1991) and global changes in temperature (Feary et al., 1991; Truswell, 1993). The vegetation became more open in the later part of the Tertiary in response to aridity and cooling global temperatures, coinciding with periods of incursions of shallow seas isolating Tasmania (and to some extent the Bass Strait islands). These changes undoubtedly involved the extinction of many taxa, particularly those associated with rainforests, as indicated by the fossil record, and speciation of possible endemic biotas within Tasmania. During the Pleistocene glaciations the exposure of the land bridges covered predominantly by grasses and woodlands (Hope, 1978), probably facilitated interchange of some of the biota associated with drier, open vegetation.

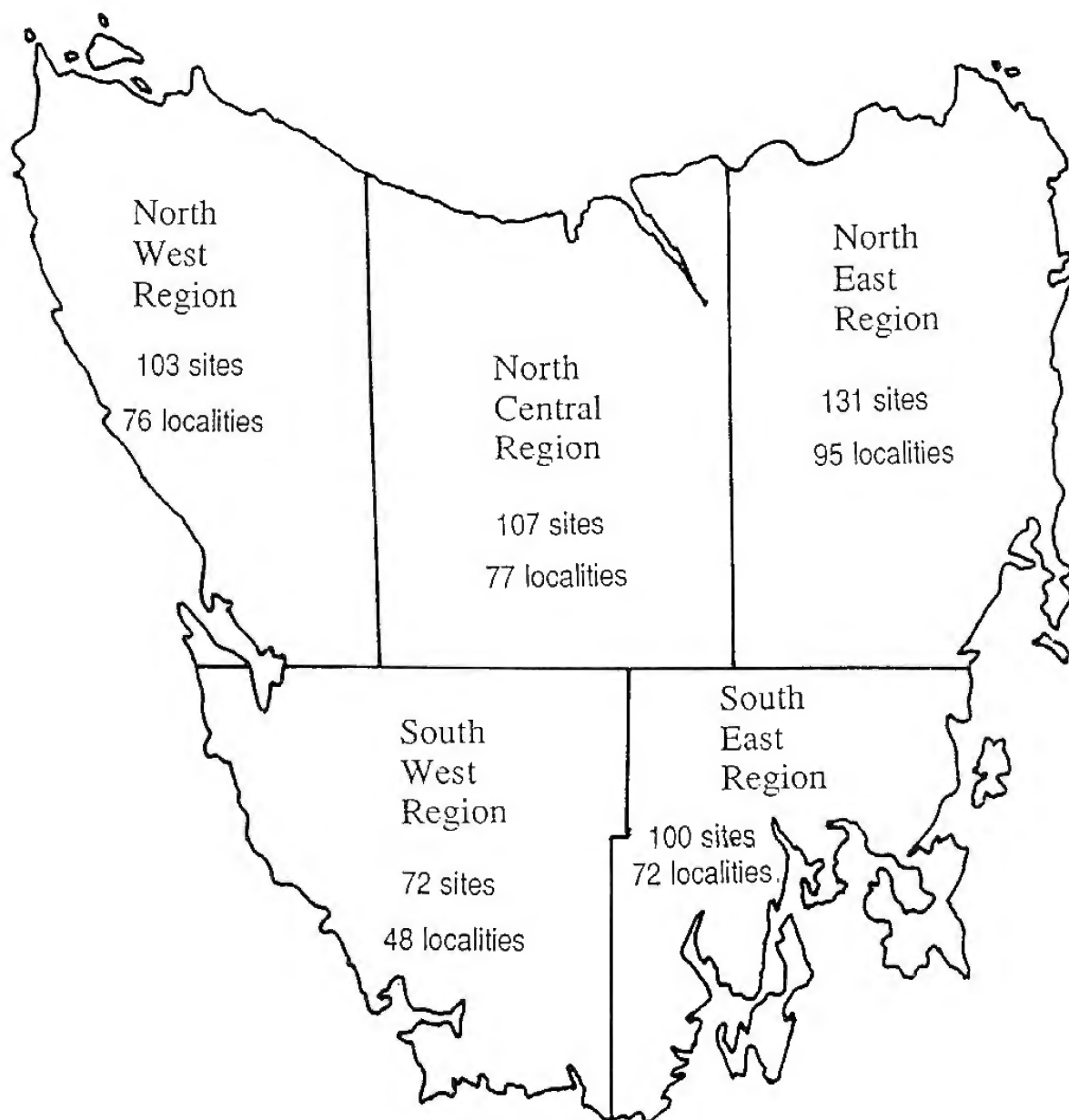


Figure 2. Summary of collecting effort for Psocoptera in Tasmania: for each of the five main regions, numbers of sites and localities are shown; full listing of sites and accompanying maps are given in Appendix 1. Localities are distributed as follows: southeast, localities 1-72; northeast, localities 73-167; north central, localities 168-244; northwest, localities 245-320; southwest, localities 321-368.

Field Methods

Intensive and extensive sampling for Psocoptera from the widest possible range of vegetation types was carried out across Tasmania. Localities of sites sampled from the five Tasmanian regions (fig. 2) are shown in detail in Appendix 1 (figs 254–58, tables 3–7). Several sites were sampled at particular localities (for example, sites 5A, 5B, 5C, 5D and 5E at locality 5, Appendix 1). In total, 513 sites were sampled at 368 localities. Sites tend to be clumped, being restricted to those localities that were accessible. Some other localities were accessible but conditions for parts of the year precluded the collection of Psocoptera. Sites sampled intensively were primarily common vegetation types, selected for their accessibility and for comparison with vegetation types of a similar survey carried out at Wilsons Promontory, Victoria (Schmidt and Thornton, 1993).

On each occasion, at each site, ten samples were taken. Each sample was obtained by beating a branch of a tree or shrub twelve times. Where a number of plant species were present at a site, an attempt was made to sample from the most frequently occurring one. Dislodged insects were aspirated from the beating tray (0.7 m²) and preserved in 75% alcohol. This sampling regime was performed at all sites sampled, except for those where grasses and sedges were sampled, and those sampled only once from isolated areas. Twenty samples were taken on each occasion from grasses and sedges, due to the smaller area of vegetation sampled. Vegetation from isolated (inaccessible) areas (such as Frenchmans Cap Walking Track, Overland Walking Track, Southwest Cape and South Coast Walking Tracks) was sampled for as long as time and weather conditions permitted.

Systematics of the Tasmanian Psocoptera

Checklist of Psocoptera from Tasmania

(With distributional notes included as follows: COS, cosmopolitan; END, implied Tasmanian endemic (not known elsewhere); SEA, known from other parts of southeastern Australia, including some or all of Bass Strait, Victoria, South Australia, New South Wales, southern Queensland; REG, regional, with wider distribution in Australia and/or nearby countries; also indicated are predominant vegetation categories in which the more abundant species were captured (singletons and some others omitted when information insufficient), as an indication of possible habitat ‘preferences’, with numbers 1–10 corresponding broadly to categories discussed in text as: 1, Rainforest; 2, Mixed Forest; 3, Blackwood Swamp Forest; 4, Wet Sclerophyll Forest; 5, Dry Sclerophyll Forest and Woodland; 6, Dry Coastal Vegetation; 7, Western Moorland and Scrub; 8, Alpine Vegetation; 9, Native Grassland; 10, Wetland and Aquatic Vegetation.

Lepidopsocidae

Pteroxanium kelloggi (Ribaga, 1905) COS 1

Tasmanian Trogiidae

Cerobasis guestfalica (Kolbe, 1880) COS 5, 6
Lepinotus huoni sp. nov. END
Lepinotus inquilinus Heyden, 1850 COS
Lepinotus patruelis Pearman, 1931 COS
Lepinotus reticulatus Enderlein, 1905 COS
Lepinotus tasmaniensis Hickman, 1934 SEA
Trogium pulsatorium (Linnaeus, 1758) COS

Psyllipsocidae

Psyllipsocus ramburii Selys-Longchamps, 1872 COS

Liposcelididae

Embidopsocus lenah sp. nov. END
Liposcelis sp. A
Liposcelis sp. B

Sphaeropsocidae

Sphaeropsocus recens (Hickman, 1934) SEA

Caeciliusidae

Aphyopsocus prolixus Smithers, 1982 SEA 4, 5, 6
Paracaecilius hilli (Smithers, 1979) SEA wide variety
Paracaecilius seltus (Schmidt and Thornton, 1993) SEA wide variety
Bassocaecilius rawlinsoni gen. nov. sp. nov. SEA 6
Clinocaecilius edwardsi gen. nov. sp. nov. END
Maoripsocus concavistigma (Schmidt and Thornton, 1993) SEA 1, 3, 4, 5, 6
Maoripsocus hobartensis sp. nov. END
Maoripsocus juneae (Schmidt and Thornton, 1993) SEA 1, 2, 4, 5
Maoripsocus pedderi sp. nov. END
Maoripsocus semifuscatus Tillyard, 1923 REG 6, 7
Maoripsocus spirulosus sp. nov. END
Maoripsocus tahunensis sp. nov. END
Maoripsocus wedgei sp. nov. END 1
Maoripsocus weindorferi sp. nov. END
Graminacaecilius frontalis gen. nov. sp. nov. SEA 9
Graminacaecilius micropterus gen. nov. sp. nov. END 9

<i>Stenocaecilius lineatus</i> (Smithers, 1977)	SEA	5
<i>Stenocaecilius quercus</i> (Edwards, 1950)	REG	3, 4, 5, 6
<i>Valenzuela pteridii</i> (Smithers, 1977)	REG	bracken
<i>Nothocaecilius thomasi</i> gen. nov. sp. nov.	SEA	?1
<i>Tasmanocaecilius truchanasi</i> gen. nov. sp. nov.	END	

Lachesillidae

<i>Lachesilla pedicularia</i> (Linnaeus, 1758)	COS	
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Ectopsocidae

<i>Ectopsocus axillaris</i> (Smithers, 1969)	COS	1, 2, 4, 5
<i>Ectopsocus briggsi</i> McLachlan, 1899	COS	wide variety
<i>Ectopsocus brunneus</i> (Edwards, 1950)	SEA	
<i>Ectopsocus californicus</i> (Banks, 1903)	COS	wide variety
<i>Ectopsocus coyae</i> sp. nov.	END	
<i>Ectopsocus edwardsi</i> New, 1973	SEA	?5
<i>Ectopsocus graminus</i> sp. nov.	END	9
<i>Ectopsocus hickmani</i> sp. nov.	END	5
<i>Ectopsocus nerens</i> (Hickman, 1934)	?END	
<i>Ectopsocus petersi</i> Smithers, 1978	COS	1, 2, 4
<i>Ectopsocus rileyae</i> Schmidt and Thornton, 1993	SEA	1, 2, 4
<i>Ectopsocus risdonensis</i> sp. nov.	END	
<i>Ectopsocus sprengi</i> sp. nov.	END	
<i>Ectopsocus vachoni</i> Badonnel, 1945	COS	
<i>Ectopsocus</i> sp.		

Peripsocidae

<i>Cycloperipsocus edwardsi</i> (New, 1973a)	SEA	
<i>Peripsocus cochleus</i> sp. nov.	SEA	1, 2
<i>Peripsocus maoricus</i> (Tillyard, 1923)	REG	wide variety
<i>Peripsocus melaleuca</i> New, 1971	SEA	1, 5, 6, 7
<i>Peripsocus milleri</i> (Tillyard, 1923)	COS	4, 5, 6
<i>Peripsocus morulops</i> (Tillyard, 1923)	REG	6, 7
<i>Peripsocus pamae</i> sp. nov.	END	wide variety
<i>Peripsocus tillyardi</i> New, 1973a	SEA	5, 6

Trichopsocidae

<i>Trichopsocus clarus</i> (Banks, 1908)	COS	
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Pseudocaeciliidae

<i>Austropsocus antennalis</i> Thornton and New, 1977	REG	4
<i>Austropsocus sinuosus</i> (Banks, 1939)	REG	1, 2, 4, 5
<i>Austropsocus tibialis</i> Thornton and New, 1977	REG	1, 2, 4
<i>Austropsocus viridis</i> (Enderlein, 1903)	REG	
<i>Chorocaecilius brunellus</i> (Tillyard, 1923)	REG	1, 2, 5, 6, 7
<i>Cladioneura pulchripennis</i> Enderlein, 1906	SEA	1, 5, 6
<i>Heterocaecilius lachlani</i> (Enderlein, 1903) ..	SEA	6
<i>Howeanum costale</i> (Thornton and New, 1977) ..	SEA	5, 6, 7
<i>Howeanum tasmaniensis</i> sp. nov.	END	
<i>Mepleres rotundatus</i> (New, 1974a)	SEA	5, 6
<i>Mepleres tanei</i> (Smithers, 1977)	SEA	

Philotarsidae

<i>Aaroniella rawlingsi</i> Smithers, 1969	REG	1, 5, 6
<i>Abelopsocus fenestratus</i> (Schmidt and Thornton, 1993)	SEA	1, 6
<i>Abelopsocus truganinia</i> gen. nov. sp. nov. ...	END	1
<i>Haplophallus sinus</i> Thornton and New, 1977 ...	SEA	5, 6
<i>Philotarsopsis guttata</i> (Tillyard, 1923)	REG	4, 5
<i>Philotarsopsis hellyeri</i> sp. nov.	END	
<i>Philotarsopsis paraguttata</i> (Thornton and New, 1977)	SEA	4, 5

Elipsocidae

<i>Diademadrilus masseyi</i> (New, 1971)	SEA	6, 7
<i>Gondwanapsocus australis</i> Schmidt and New, 2004a	END	7
<i>Onychophallus diemenensis</i> Schmidt and New, 2004a	END	1
<i>Paedomorpha gayi</i> Smithers, 1963	REG	
<i>Pentacladus eucalypti</i> Enderlein, 1906	REG	4, 5
<i>Propsocus frodshami</i> sp. nov.	END	
<i>Propsocus pallipes</i> (McLachlan, 1866)	REG	5
<i>Propsocus pulchripennis</i> (Perkins, 1899)	COS	

<i>Telmopsocus waldheimensis</i> Schmidt and New, 2004a	END	1
<i>Villopsocus tasmaniensis</i> Schmidt and New, 2004a	END	

Psocidae

<i>Blaste bistriata</i> Schmidt and Thornton, 1993	SEA	
<i>Blaste falcifer</i> Smithers, 1979	END	1, 7
<i>Blaste lignicola</i> (Enderlein, 1906)	REG	5, 6
<i>Blaste panops</i> Smithers, 1979	END	
<i>Blaste taylori</i> New, 1974b	REG	1, 2, 6, 7
<i>Blaste tillyardi</i> Smithers, 1969	REG	
<i>Clematostigma maculiceps</i> (Enderlein, 1903)	SEA	4
<i>Ptycta australis</i> Schmidt and Thornton, 1993	SEA	6, 7
<i>Ptycta campbelli</i> Schmidt and Thornton, 1993	SEA	wide variety
<i>Ptycta colei</i> sp. nov.	SEA	
<i>Ptycta emarginata</i> New, 1974b	REG	6
<i>Ptycta freycineti</i> sp. nov.	END	6
<i>Ptycta glossoptera</i> New, 1974b	SEA	6
<i>Ptycta pallawahensis</i> sp. nov.	END	1, 7
<i>Ptycta umbrata</i> New, 1974b	SEA	6
<i>Tanystigma edwardsi</i> (New, 1974b)	SEA	5, 6
<i>Tanystigma inglewoodense</i> (New, 1974b)	SEA	4, 5, 6, 7
<i>Tanystigma maddenii</i> sp. nov.	END	6
<i>Tanystigma tardipes</i> (Edwards, 1950)	SEA	6
<i>Tanystigma westae</i> sp. nov.	END	

Myopsocidae

<i>Nimbopsocus australis</i> (Brauer, 1865)	REG	
<i>Nimbopsocus hickmani</i> (Smithers, 1964)	SEA	

Systematics

In the following systematic treatment, drawings from permanent preparations were made with the aid of a camera lucida. Measurements of body parts are given in mm, and the method used for determining the ratio of interocular distance to diameter of eye (IO:D in systematic treatment below) was that of Pearman, as described by Ball (1943). The following abbreviations are used: B, body length; FW, length of fore wing; HW, length of hind wing; F, length of hind femur; T, length of hind tibia; t1, t2, t3, length of basal, second and apical tarsal segments respectively; rt, ratio of t1 and t3 to t2; ct, number of ctenidia on hind tarsal segments; f1, length of basal flagellar segment; f2, length of second flagellar segment.

Additional measurements for *Embidopsocus*: SI, longest seta on the lateral margin of the pronotum; Sa, length of a specific long seta; Se, length of the longest seta on the epiproct (Badonnel, 1955, cf longest seta on the paraproct, Mockford, 1963). Scale lines on figures equal 0.1 mm unless otherwise indicated. Holotypes and paratypes are deposited in the Australian Museum, Sydney, unless otherwise indicated.

Key to Tasmanian families of Psocoptera

1. Labial palpi with two segments 2
 - Labial palpi with one segment Psocomorpha 6
2. Paraproct with large anal spine; flagellum beyond segments 4 or 5 without secondary annulations Trogiomorpha 3
 - Paraproct without large anal spine; flagellum beyond segments 4 or 5 with secondary annulations Troctomorpha 5
3. Body and wings with flattened scales Lepidopsocidae
 - Body and wings without flattened scales 4
4. Tarsal claws without subapical tooth Trogiidae
 - Tarsal claws with subapical tooth Psyllipsocidae
5. Body dorsoventrally flattened, hind femora enlarged Liposcelididae
 - Body not dorsoventrally flattened, hind femora not enlarged Sphaeropsocidae
6. Frons absent Peripsocidae
 - Frons present 7
7. Tarsi 2-segmented 8
 - Tarsi 3-segmented 14
8. Setae on hind wing margin at most between radial fork 9
 - Setae around margin of hind wing 12
9. Pulvillus broad Ectopsocidae
 - Pulvillus narrow 10
10. Apterous, or fore wing strongly setose Elipsocidae
 - Fore wing glabrous 11
11. Areola postica joined to *m* Psocidae
 - Areola postica free Lachesillidae
12. Marginal setae crossing each other at fore wing apex Pseudocaeciliidae
 - Marginal setae not crossing each other at fore wing apex 13
13. Setae around margin of hind wing of uniform length Caeciliusidae

- Setae around hind wing margin alternately longer and shorter Trichopsocidae
- 14. Setae on hind wing margin at most between radial fork 15
- Setae around margin of hind wing 16
- 15. Fore wing strongly mottled Myopsocidae
- Fore wing without mottled pattern Elipsocidae
- 16. Marginal setae crossing each other at hind wing apex Philotarsidae
- Marginal setae not crossing each other at hind wing apex Pseudocaeciliidae

Lepidosocidae

Pteroxanium Enderlein

Pteroxanium Enderlein, 1922: 102. Type species: *Pteroxanium squamosum* Enderlein.

Pteroxanium kelloggi (Ribaga)

Lepidilla kelloggi Ribaga, 1905: 100.

Tasmanopsocus litoralis Hickman, 1934: 78.

Pteroxanium kelloggi. --- Roesler, 1943: 13.

For complete synonymy see Lienhard and Smithers (2002).

Material examined. **Site** 21, 6♀, 17 Feb 88; **site** 40, 1♀, 23 Apr 87; **site** 42A, 1 ♀, 12 June 86; **site** 77, 1♀, 29 June 86; **site** 94, 1♀, 27 June 86; **site** 185, 2♀, 1 nymph, 15 June 86; 1♀, 17 June 87; **site** 248A, 1♀, 25 Oct 86; 1♀, 1 Mar 87; 2 nymphs, 28 June 87; 1 nymph, 30 July 87; **site** 264B, 1♀, 22 Sep 86; **site** 294B, 8♀, 4 Mar 88.

Distribution. Cosmopolitan.

Remarks. This species, which appears to have been transported by human agency (Smithers, 1972), is known in Australia only from Tasmania. Interestingly, the majority of specimens collected in this study were taken from two sites of huon pine (*Lagarostrobos franklanii*), which is usually found along riverbanks and is endemic to southwestern Tasmania.

Trogiidae

Key to Tasmanian genera of Trogiidae

1. Head and abdomen without pattern, distal segment of maxillary palp elongate *Lepinotus* Heyden
- Head and abdomen with obvious pattern, distal segment of maxillary palp broad 2
2. In addition to apical spines, one or two subapical spines on hind tibia *Cerobasis* Kolbe
- Only apical spines on hind tibia *Trogium* Illiger

Cerobasis Kolbe

Cerobasis Kolbe, 1882b: 212. Type species: *Cerobasis muraria* Kolbe.

Cerobasis guestfalica (Kolbe)

Hyperetes guestfalicus Kolbe, 1880: 132.

Cerobasis guestfalica Roesler, 1943: 13.

Material examined. Many females and nymphs collected throughout the year.

Distribution. Cosmopolitan.

Remarks. This species was collected from many sites of dry coastal vegetation from eastern, northern and northwestern Tasmania. *C. guestfalica* was particularly abundant throughout the year on *Banksia serrata*.

Lepinotus Heyden

Lepinotus Heyden, 1850: 84. Type species: *Lepinotus inquilinus* Heyden.

Key to Tasmanian species of Lepinotus

1. Postclypeus with obvious reticulated pattern *inquilinus* Heyden
- Postclypeus without reticulated pattern 2
2. Brown stripe between eye and antenna base *patruelis* Pearman
- Brown stripe absent between eye and antenna base 3
3. Parietal glands present, paraproct without ventral sclerotised bar *tasmaniensis* Hickman
- Parietal glands absent, paraproct with ventral sclerotised bar 4
4. Body uniformly dark brown (iridescent pink dorsally on fresh specimens), wings absent *huoni* sp. nov.
- Abdomen clearly paler than rest of body, wings reticulate *reticulatus* Enderlein

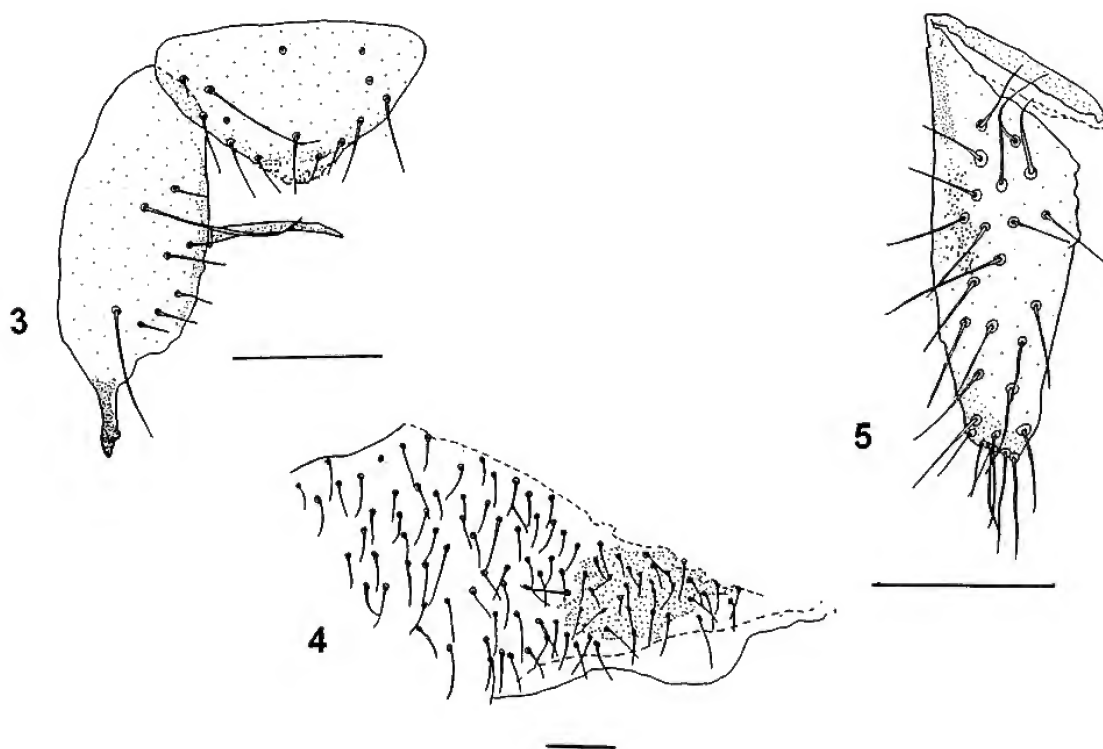
Lepinotus huoni sp. nov.

Figures 3–5

Material examined. Holotype ♀: Tasmania, Tahune Forest Reserve, Pine Tk, *Lagarostrobos franklanii*, 17 Feb 1988. Five ♀ paratypes: same data as holotype.

Description of female. **Coloration** (after ca 5 years in alcohol). Head dark brown. Median epicranial suture black. Antenna brown, maxillary palp brown, apical segment dark brown. Eyes black. Thorax and legs dark brown, tarsi brown. Abdomen dorsally dark brown, cream ventrally, terminal segments dark brown. Freshly killed specimens bright iridescent pink on vertex, dorsal surfaces of thorax and abdomen, and femora. This coloration fades in alcohol.

Morphology. IO:D = 2.3. Eyes ovoid, dorsal margin in line with top of vertex. Antenna complete with 26 flagellar segments (paratype). Distal margin of labrum with anterior row of 5 trichoid sensilla and posterior row of 4 trichoid sensilla. Vertex fairly sharp, postclypeus flattened. Clypeal shelf broad. Lacinia bifid, lateral projection larger than median. Ocelli absent. Apical



Figures 3-5. *Lepinotus huoni*. Female: 3, epiproct and paraproct; 4, subgenital plate; 5, gonapophyses.

segment of maxillary palp broad, second segment with large sensillum. Reticulate pattern on vertex and postclypeus barely visible. Head, including eyes, and thorax bearing scattered setae of differing lengths. Tibiae with 2 apical spurs. Hind tibia with 4 (paratype) long fine setae on outer margin, length about 3 to 4 times width of tibia. A single long, fine seta of similar length on middle of mid tibia. Ctenidiobothria absent. Tarsi 3-segmented, claw lacking subapical denticle. Pulvillus fine, apically broadened. Abdomen with tergites well sclerotised, each bearing two incipient rows of long setae. Sternites not sclerotised, bearing dense shorter setae. Epiproct (fig. 3) simple, setose. Paraproct (fig. 3) lacking trichobothria, with strong posterior spine and ventral sclerotised bar. Subgenital plate (fig. 4) simple, setose, with broad triangular pigmented area. Gonapophyses (fig. 5) with large setose external valve, and sclerotised dorsal valve remnant. Spermathecal duct present, parietal glands apparently absent.

Dimensions. B 2.0, F 0.411, T 0.553, t_1 0.174, t_2 0.047, t_3 0.047, rt 3.7:1:1, f_1 0.087, f_2 0.067.

Male. Unknown.

Remarks. This rare species, collected only from huon pine in southern Tasmania, differs from all other known species in the

genus by the coloration (fresh material). *Lepinotus huoni* also differs from *Lepinotus tasmaniensis* and *Lepinotus stoneae* Smithers (NSW) by the absence of reticulated wings and parietal glands.

Etymology. Named for the French explorer, Jean-Michel Huon de Kermadec.

***Lepinotus inquilinus* Heyden**

Lepinotus inquilinus Heyden, 1850: 84.

Distribution. Cosmopolitan.

Remarks. This species has been recorded from Tasmania previously (Hickman, 1934; Smithers, 1979). No additional material was collected in this study.

***Lepinotus patruelis* Pearman**

Lepinotus patruelis Pearman, 1931: 47.

Material examined. Old Farm Rd, leaf litter, Eucalypt forest, 1♀, 20 Jun 89 (P. Greenslade); Big Sassy Ck, Site 1, PKD Sassafra, 2♂, 17 May 89 (J. Diggle); Big Sassy Ck, Site 1, Soil Cores, 1♂, 12 May 89

(H. Mitchell, J. Diggle); Mt Mangana, Bruny I, Site 2, leaf litter, 1♂, 9 Apr 89 (P. Greenslade); Mt Mangana, Bruny I, Site 2, moss on dead log 2A+B, 1♀, 4–9 Apr 89 (P. Greenslade, J. Diggle) (MV).

Distribution. Cosmopolitan.

Remarks. This species has been recorded previously from litter in southwestern Tasmania (Smithers, 1979). It was not collected during the present study.

***Lepinotus reticulatus* Enderlein**

Lepinotus reticulatus Enderlein, 1905: 31.

!*Lepinotus reticulatus*. --- Schmidt and Thornton, 1993: 148.

Material examined. Site 79, 1♀, 3 Feb 87; site 159A, 1♀, 9 Aug 86.

Distribution. Cosmopolitan.

Remarks. In Australia this species has been recorded from South Australia, Curtis I (Bass Strait) and recently from Wilsons Promontory, Victoria. Closer examination of the Wilsons Promontory material has revealed an error in identification; they are clearly conspecific with Tasmanian material of *Lepinotus tasmaniensis*.

Reticulate wings are not present on the material examined. The reticulate pattern on the vertex and postclypeus is absent and no parietal glands are evident. The sensillum on the second segment of the maxillary palp (Enderlein, 1905, plate 2, fig. 19) appears similar in size to that of *Lepinotus tasmaniensis*, which is smaller than that of *Lepinotus huoni*. The paraprocts possess a ventral sclerotised bar as found in *Lepinotus huoni*, but this is absent in *Lepinotus tasmaniensis* and *Lepinotus stoneae*. The referral of this material to *L. reticulatus* is provisional.

***Lepinotus tasmaniensis* Hickman**

Lepinotus tasmaniensis Hickman, 1934: 81.

Lepinotus reticulatus Enderlein. Schmidt and Thornton, 1993: 148.

Material examined. Site 248A, 1♀, 28 June 87; 2♀, 29 Feb 88; site 294B, 1♀, 4 Mar 88.

Distribution. Tasmania and Victoria.

Remarks. Hitherto known only from Tasmania, *Lepinotus tasmaniensis* is now known from both sides of Bass Strait (see remarks under previous species). Closer examination of material from Curtis I, Bass Strait, referred to *L. reticulatus* by New (1971) may therefore be warranted.

Trogium Illiger

Trogium Illiger, 1798: 500. Type species: *Termes pulsatorium* Linnaeus.

***Trogium pulsatorium* (Linnaeus)**

Termes pulsatorium Linnaeus, 1758: 610.

Trogium pulsatorium. --- Illiger, 1798: 500.

Material examined. Old Farm Rd, leaf litter, Eucalypt forest, 1♀, 20 Jun 89 (P. Greenslade); Savage River Pipeline Rd, Site 2, litter, 1♂, 21 Apr 89 (P. Greenslade) (MV).

Distribution. Cosmopolitan.

Remarks. Previously recorded in Tasmania by Hickman (1934), this species was not found in the present study.

Psyllipsocidae

***Psyllipsocus* Selys-Longchamps**

Psyllipsocus Selys-Longchamps, 1872: 145. Type species: *Psyllipsocus ramburii* Selys-Longchamps.

***Psyllipsocus ramburii* Selys-Longchamps**

Psyllipsocus ramburii Selys-Longchamps, 1872: 145.

Distribution. Cosmopolitan.

Remarks. This species has been recorded previously from southwestern Tasmania (Smithers, 1979) from litter. No additional material was collected in this study.

Liposcelididae

Key to Tasmanian genera of Liposcelididae

1. Macropterous and apterous, eyes of apterous forms with at most two ommatidia *Embidopsocus* Hagen
- Apterous, eyes with 6–8 ommatidia *Liposcelis* Motschulsky

***Embidopsocus* Hagen**

Embidopsocus Hagen, 1866a: 170. Type species: *Embidopsocus luteus* Hagen.

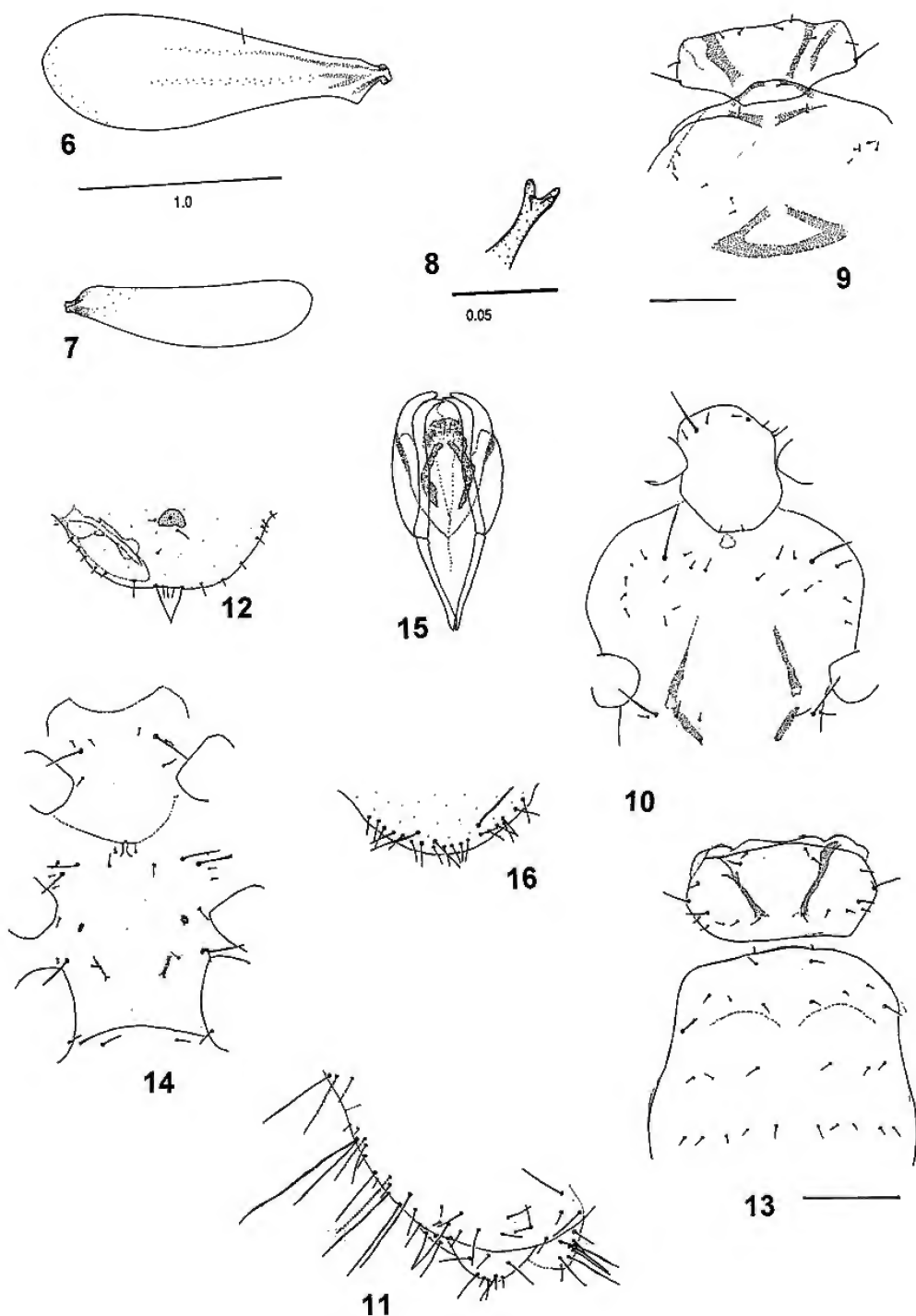
***Embidopsocus lenah* sp. nov.**

Figures 6–16

Material examined. Holotype ♀: Tasmania, Lenah Valley, under bark, 26 May 1937. Two ♂ paratypes: same data as holotype. Additional record (1♀): Lenah Valley, under bark of dead tree, 21 Feb 1934 (V. V. Hickman).

Description of macropterous female. *Coloration* (after ca 56 years on permanent slide). Light (straw) brown. Eyes black. Ocelli pale, centripetal margins black (from other specimen). Fore wing (fig. 6) very pale brown, veins brown. Hind wing (fig. 7) pale.

Morphology. Ocelli well developed, compound eyes consisting of many ommatidia. Apex of lacinia (fig. 8) with long bifid lateral projection, a long median projection and in between a short projection with apex directed medially. Apical segment of maxillary palp with a field of 8 thin-walled setae, the lengths and distribution of which are similar to those described for the *laticeps* complex (Mockford, 1987: 852). Flagellar sensilla as in Table 2, following the categories suggested by Mockford (1987). Anterior margin of postclypeus with 2 long median setae, in addition to several shorter setae laterally. Short setae sparsely scattered on vertex and frons. Fore wing with single row of short sparse setae on radial vein in basal third of wing, setae restricted to base of medial vein,



Figures 6-16. *Embidopsocus lenah*. Female: 6, fore wing; 7, hind wing; 8, lacinia; 9, thoracic terga; 10, thoracic sternite; 11, posterior abdominal terga (setae from sternite dotted); 12, subgenital plate. Figures 6, 7 and 9-12 to common scales. Male: 13, thoracic terga; 14, thoracic sternite; 15, phallosome; 16, hypandrium. Figures 13-16 to common scale.

posterior margin bearing 3 setae at base of wing. Chaetotaxy: thoracic terga (fig. 9) with one (humeral) seta on each side of pronotum; thoracic sterna (fig. 10) with pair of large setae (one missing in preparation) and row of smaller setae on anterior margin of prosternum, meso-metasternum with setae concentrated along its anterior margin and a few scattered along its sides. Hind femur with 2 long setae, hind tibia with 5 long setae of various lengths. Tarsal claw with a series of denticles basal to large subapical tooth. Chaetotaxy of posterior abdominal terga as in fig. 11. Sculpture of integument of head and terga of thorax and abdomen absent. Portion of gonapophyses seen (after clearing) through subgenital plate (dotted in fig. 12). Spermathecal plate (fig. 12) rounded anteriorly. Spermatheca very large, spherical (0.11–0.14 mm diameter, other specimen).

Dimensions. B 1.74, FW 1.54, HW 1.06, $F_{(l)}$ 0.356, $F_{(w)}$ 0.126, T 0.276, t_1 0.063, t_2 0.032, t_3 0.047, rt 2:1:1.5. f_1 0.075, f_2 0.067, S_1 0.036, S_a 0.158, S_c 0.055.

Description of apterous male. **Coloration** (after ca 56 years on permanent slide). As female.

Morphology. Ocelli absent. Eyes reduced to 2 ommatidia on each side of head. Chaetotaxy of thoracic terga as in fig. 13, thoracic sterna (fig. 14) with row of setae along anterior margin of prosternum reduced, a single large seta near each anterolateral margin. Sculpture of integument as female, except for a few vague lines along posterior margin of head. Remaining morphology as that of female. Phallosome (fig. 15) with parameres coming together anteriorly, endophallus finely serrate. Hypandrium (fig. 16) with pair of large preapical setae.

Dimensions. B 1.15, $F_{(l)}$ 0.308, $F_{(w)}$ 0.118, T 0.229, t_1 0.047, t_2 0.032, t_3 0.043, rt 1.5:1:1.37, f_1 0.063, f_2 0.063, S_1 0.024, S_a 0.103, S_c 0.063.

Remarks. Badonnel (1955) divided this genus into three species groups, utilising several important characters found in apterous females. Additional species from Argentina (Badonnel, 1962), Brazil (Badonnel, 1972), and Central and North America (Mockford: 1963, 1987) have been placed within these groups. A single damaged apterous female is known from the holotype

locality; the sclerotised bands of the mesosternum are present laterally but they do not fuse to form a closed arc, nor are they joined to the pro-mesothoracic spina. At present *E. lenah* cannot be placed into any of the above groups with certainty.

A single individual of this genus has been collected in Victoria (New, 1975).

Etymology. The species name is an indigenous word for kangaroo.

Liposcelis Motschulsky

Liposcelis Motschulsky, 1852: 19. Type species: *Liposcelis brunnea* Motschulsky.

Liposcelis spp.

Material examined. *Liposcelis* sp. A: Mt Victoria, moss on tree, 1♀, 29 Nov 89 (R. Coy); Bradshaws Rd, Site 1, moss on rocks, 1♀, 21 Apr 89 (P. Greenslade); Mt Mangana, Bruny I, Site 2, moss on log, 1♂, 9 Apr 89 (P. Greenslade); Mt Mangana, Bruny I, Site 2, moss on dead logs 1A, 1♂, 9 Apr 89 (P. Greenslade). *Liposcelis* sp. B: Mt Field, *N. gunnii*, suction no. 2, 1♀, 9 Oct 89 (R. Coy); Mt Field, *N. gunnii*, soil cores, 1♀, 1 nymph, 25 Aug 89 (R. Coy); Projection Bluff, soil cores, 2♀, 3 nymphs, 9 Mar 89 (J. Diggle); Mt Mangana, Bruny I, Site 2, moss on live trees, 1♀, 4 Apr 89 (J. Diggle) (MV).

Remarks. Several specimens of two species of *Liposcelis* were examined. As Smithers (1991) noted, these cannot be identified until further work has been done on Australian members of this genus. One species was determined by ERS, possibly incorrectly, as *Liposcelis decolor* (Pearman) (Coy et al., 1993).

'*Liposcelis divinatorius*' (Müller) was recorded from Tasmania by Hickman (1934). This name is now considered a *nomen dubium* (Lienhard, 1990).

Sphaeropsocidae

Sphaeropsocopsis Badonnel.

Sphaeropsocopsis Badonnel, 1963: 322. Type species: *Sphaeropsocopsis chilensis* Badonnel.

Table 2. Nature and distribution of distal thin-walled setiform sensilla on flagellar segments for n individuals of *E. lenah* (setal terminology after Mockford, 1987).

macropterous	f1	f2	f3	f4	f5	f6
n=1	1(IIa2aa)	1(IIa1bb)	1(IIb2cc)	1(IIb2dd)	1(IIb1dd)	1(IIb1dd)
			1(IIa2aa)	1(IIa2cc)		
	f7	f8	f9	f10	f11	f12
	1(IIIb3ee)	1(IIIb3ee)	1(IIIb3ee)	1(IIIb2ee)	1(IIIb3ee)	1(IIb3dd)
apterous	f1	f2	f3	f4	f5	f6
n=2	1(IIa2aa)	1(IIb1aa)	1(IIb3dd)	1(IIIb3ee)	1(IIb1dd)	1(IIb2dd)
	f7	f8	f9	f10	f11	f12
	1(IIIc3ee)	1(IIIc3ee)	1(IIIc3ee)	1(IIb1dd)	1(IIIc3ee)	1(IIIb3ee)

Sphaeropsocopsis recens (Hickman)*Sphaeropsocus recens* Hickman, 1934: 83.*Sphaeropsocopsis recens*. --- Badonnel, 1963: 323.

Material examined. The (Queens) Domain (Hobart), from loose bark on eucalypt, 2♀, 13 Apr 1968 (V. V. Hickman).

Distribution. Tasmania and South Australia.

Remarks. Not collected during the present study despite several targeted searches at the holotype locality (Trevallyn Gorge, Launceston) and from the Domain, Hobart. Although not recorded formally from Victoria, TRN has collected this species from grass tussocks near Narbethong.

Caeciliusidae**Key to Tasmanian subfamilies of Caeciliusidae**

1. Basal flagellar segment of antenna enlarged Aphyopsocinae Mockford
- Basal flagellar segment of antenna not enlarged 2
2. Seven sensilla on distal margin of labrum, three ventral abdominal vesicles present Paracaeciliinae Mockford
- Five sensilla on distal margin of labrum, at most two ventral abdominal vesicles present Caeciliusinae Mockford

Aphyopsocinae Mockford**Aphyopsocus** Smithers

Aphyopsocus Smithers, 1982: 13. Type species: *Aphyopsocus prolixus* Smithers.

Aphyopsocus prolixus Smithers

Aphyopsocus prolixus Smithers, 1982: 14.

Material examined. **Site** 35A, 1♀, 20 Feb 87; **site** 103, 1♀, 21 Feb 88; **site** 121A, 1♂, 10 Nov 86; **site** 159B, 1♂, 23 Feb 88; **site** 159C, 9♀, 1♂, 19 Apr 87; 6♀, 5♂, 23 Feb 88; **site** 177, 1 nymph, 9 Feb 87; **site** 180A, 6♀, 1♂, 1 nymph, 13 Nov 86; 4♀, 2♂, 8 Dec 86; 3♀, 20 Jan 87; 1♂, 18 Mar 87; 1 nymph, 31 July 87; 1♀, 26 Feb 88; **site** 248A, 1♂, 24 Aug 86; 4♀, 23 Sep 86; 1♀, 25 Oct 86; 1♂, 24 Jan 87; 2♀, 1♂, 1 Mar 87; 1♀, 1♂, 23 May 87; 1♀, 28 June 87; 3♀, 30 July 87; **site** 248B, 1♀, 14 June 86; **site** 280A, 1♂, 26 Jan 87.

Distribution. Tasmania and New South Wales.

Remarks. This species, collected throughout the year, is most common on broad-leaved vegetation such as *Banksia serrata* and in wet forest *Olearia argophylla*. Interestingly, for a limited time many individuals were found on *Monotocca* sp., a very different plant which at the locality (site 159C) was an understorey species of the salt- and drought-tolerant species *Casuarina stricta*. In addition to the two states listed above ERS has collected this species from eastern Victoria and Queensland.

Paracaeciliinae Mockford**Paracaecilius** Badonnel

Paracaecilius Badonnel, 1931: 235. Type species: *Paracaecilius berlandi* Badonnel.

Key to Tasmanian species of Paracaecilius

1. Fore wing sparsely setose, body creamy-white *hilli* (Smithers)
- Fore wing strongly setose, body buff *seltus* (Schmidt and Thornton)

Paracaecilius hilli (Smithers)

Enderleinella hilli Smithers, 1979: 62.

Paracaecilius hilli. --- Smithers, 1994a: 126.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania and Victoria.

Remarks. This locally widespread species was found on many, predominantly broad-leaved plant species in wet environments. In dry environments it was also common on broad-leaved trees and shrubs such as *Acacia melanoxylon*, *Banksia serrata* and *Myoporum insulare*. Smithers (1979) indicated that the costal vein in the region of the pterostigma and proximal to it is thickened in *Paracaecilius zelandicus* (Tillyard), but is narrow in *Paracaecilius hilli*. Examination of additional material suggests that this characteristic is somewhat variable in the latter species, most possessing those features noted in *P. zelandicus*.

Paracaecilius seltus (Schmidt and Thornton)

Enderleinella selta Schmidt and Thornton, 1993: 157.

Enderleinella zelandica (Tillyard). Cole et al., 1989: 33.

Enderleinella sp. Z. Coy et al., 1993: 77.

Paracaecilius seltus. --- Mockford, 2000: 364.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is and Victoria.

Remarks. This species is probably the most widespread member of the family in Tasmania. It was abundant on *Nothofagus*, the rainforest conifers, and on shrubs in mixed forest sites. It was also numerous at several dry coastal scrub and dry forest sites, such as *Callitris rhomboidea*. In the description of this species the figure of the subgenital plate (Schmidt and Thornton, 1993: 158, fig. 56) is incorrect; this has been rectified (erratum: Schmidt and Thornton, 1993). Specimens from the Bass Strait Is (Cole et al., 1989) are of this species.

Caeciliusinae Mockford**Key to Tasmanian tribes of Caeciliusinae**

1. Body pale, lacinial tip slender, bidentate or rounded *Coryphacini* Mockford

- Body dark, lacinial tip broad, denticulate 2
- 2. Two abdominal vesicles Maoripsocini Mockford
- One or no abdominal vesicles 3
- 3. Clypeal shelf broad Bassocaeciliini new tribe
- Clypeal shelf narrow Epicaeciliini Mockford

Bassocaeciliini new tribe

Diagnosis. With the characters of the subfamily (Mockford, 2000) plus the following: clypeal shelf broad; labral stylets present; lacinial tip broad, denticulate; body dark; lateral apophyses of subgenital plate absent; ventral abdominal vesicles single or absent; wings very elongated, narrow, without pattern; papillae on male epiproct and paraproct absent.

Remarks. In what he described as a progress report, Mockford (2000) outlined a combination of characters associated with the five new tribes of the subfamily Caeciliusinae. The distribution of the distal inner labral sensilla excludes one tribe (Caeciliusini) from the Australian fauna, as only labral sensilla type 2 (Mockford 2000: 393, fig. 4) are found in all Australian genera of this subfamily. The genera represent each of the four remaining tribes. A broad clypeal shelf is found only in Coryphacini, but in genera of that tribe the lacinial tip is slender, its shape bicuspid, bilobed or rounded. An absence of both ventral abdominal vesicles and papillae on the male epiproct are characters of Epicaeciliini. However, genera of this tribe possess a clypeal shelf that is narrow or absent, and a lacinial tip that is very wide. Genera within Kodamaiaini (not known from Tasmania) and Maoripsocini lack a broad clypeal shelf, and possess two abdominal vesicles. The lacinial tip in the former tribe is of medium width, with one or two shallow denticles between cusps, while in the latter tribe it is broad and denticulate. The above combination of characters is not found in any tribes within Caeciliusinae, and therefore Bassocaeciliini is established.

Key to Tasmanian genera of Bassocaeciliini

- 1. No abdominal vesicles, vein cu_2 of fore wing setose *Bassocaecilius* gen. nov.
- One abdominal vesicle, vein cu_2 of fore wing glabrous *Clinocaecilius* gen. nov.

Bassocaecilius gen. nov.

Diagnosis. With the characters of the tribe plus the following: ventral abdominal vesicles absent; vein cu_2 of fore wing setose; macropterous or micropterous (ocelli reduced, trichobothria absent) females.

Type species: *Bassocaecilius rawlinsoni* sp. nov.

Remarks. Dense short setae found on the ventral surface of the abdomen (although more profuse on the dorsal surface) may perform a function similar to that of the adhesive vesicles. This genus is also unusual in the Caeciliusidae in that both micropterous (possessing rudimentary fore wings, reduced

ocelli, and lacking developed thoracic lobes and trichobothria) and macropterous female forms have been found.

Etymology. The generic name is a combination of the name Bass, after the British naval surgeon and explorer George Bass, and *Caecilius*, a genus of Caeciliusidae.

Bassocaecilius rawlinsoni sp. nov.

Figures 17–25

Material examined. Holotype micropterous ♀: Tasmania, Mt William National Park, sedge, 8 Nov 1986. One nymph, 11♀ and 6♂ paratypes: same data as holotype. Description of macropterous ♀: Victoria, Cape Otway National Park, sedge, 11 Apr 1991. Additional records: **site** 42B, 3♀, 2 nymphs, 12 June 86; 1♀, 1 nymph, 18 July 86; 1♀, 7 nymphs, 2 Oct 86; 1♂, 1 nymph, 3 Nov 86; 1♂, 8 July 87; **site** 158 (holotype locality), 1♀, 6♂, 2 nymphs, 5 June 86; 3♀, 1♂, 1 nymph, 11 July 86; 5♀, 1♂, 2 nymphs, 9 Aug 86; 4♀, 7♂, 4 nymphs, 12 Sep 86; 2♀, 4♂, 1 nymph, 12 Oct 86; 5♀, 4♂, 1 nymph, 7 Dec 86; 2♂, 18 Jan 87; 2♀, 5 Feb 87; 1♂, 1 nymph, 23 Mar 87; 2♀, 4♂, 14 June 87; 3♀, 1♂, 25 July 87; 1♀, 23 Feb 88.

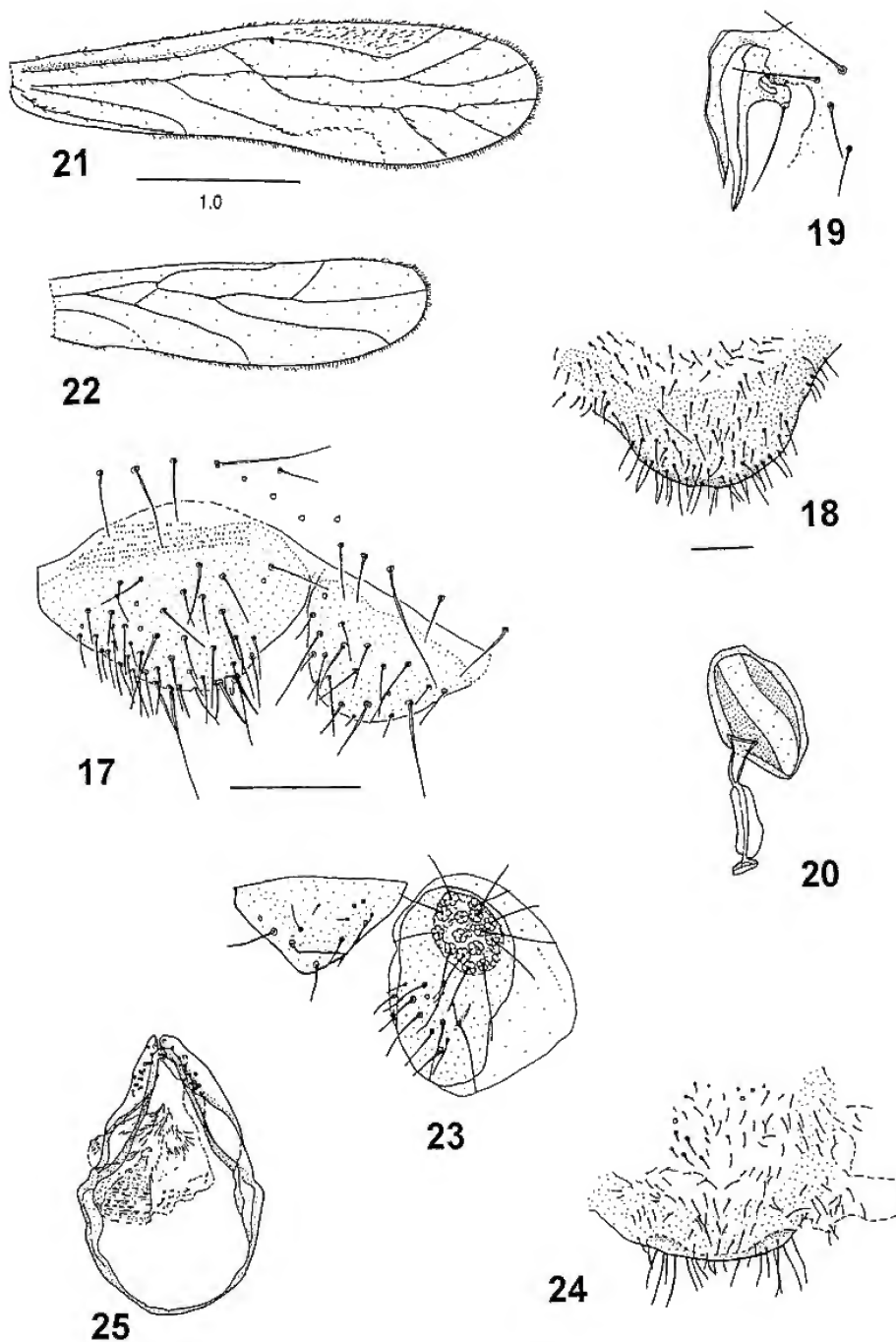
Description of micropterous female. *Coloration* (after ca 6 years in alcohol). Head brown, with darker brown band laterally across vertex half way between ocelli and crest, extending to region between eye and antennal socket. Frons with small dark brown markings. Maxillary palp, antenna and labrum dark brown. Ocelli pale, with small dark centripetal margins. Rudimentary wings brown. Thorax brown. Legs: coxae and tarsi brown, trochanter pale, femora dark brown, tibiae brown merging dark brown apically, claws black. Abdomen pale brown dorsally, cream ventrally. Terminal segments brown.

Morphology. IO:D = 5.0. Eyes and ocelli small. Labrum: stylets large, spiculate; distal anterior margin with 5 sensilla; internal sclerotisation present. Lacinia broad, flat, expanded preapically on one side, with apical denticles. Vertex flattened, elongated. Epicranial suture on posterior half of vertex distinct. Fore wing reduced to a rudimentary flap, setose. Hind wing absent. Thoracic lobes not developed. Abdomen elongate, covered by dense small dark setae which are more profuse dorsally, ventral vesicles lacking. Epiproct and paraproct (fig. 17) setose, latter lacking trichobothrial field and possessing a small apically bifid projection between two macrosetae on posterior margin. Subgenital plate (fig. 18) very setose, margin round, well pigmented with short anteriorly diverging sclerotised areas. Gonapophyses (fig. 19) with external valve sometimes represented by one seta, otherwise absent. Spermatheca (fig. 20) with relatively long glandular area.

Dimensions. B 2.4, F 0.37, T 0.58, t_1 0.134, t_2 0.103, rt 1.3:1, ct 0.0, f_1 0.190, f_2 0.134.

Description of macropterous female. *Coloration* (after ca 1 year in alcohol). As micropterous female. Wings hyaline with brown tinge, veins brown.

Morphology. IO:D = 4.3. Basal flagellar segment not enlarged, bent. Vertex flattened, elongated. Ocelli more prominent than in micropterous female. Wings elongate, narrow. One specimen with fore wing venation asymmetrical – one fore wing with veins *rs* and *m* fused for a short length – on the other these veins are separate with no cross vein joining them.



Figures 17-25. *Bassocaecilius rawlinsoni*. Female: 17, epiproct and paraproct; 18, subgenital plate; 19, gonapophyses; 20, spermathecal sac. Male: 21, fore wing; 22, hind wing; 23, epiproct and paraproct; 24, hypandrium; 25, phallosome. Figures 17, 19, 20, 23, 25; 18, 24 and 21 and 22 to common scales.

Pterostigma and areola postica low, elongate. Vein cu_1 only partially developed and the radial vein not forked in both wings examined. Vein cu_2 setose. Legs and antenna longer than in micropterous female. Mesothoracic precoxal suture absent. Abdomen as in micropterous female. Genitalia as in micropterous female except paraproct with small field of 13 trichobothria, the apically bifid projection on the posterior margin larger than in micropterous female, adjacent to a single large macroseta.

Dimensions. B 2.5, FW 2.27, HW 1.90, F 0.41, T 0.63, t_1 0.158, t_2 0.111, rt 1.4:1, ct 0.0, f_1 0.229, f_2 0.158.

Description of male. *Coloration* (after ca 6 years in alcohol). As micropterous female. Fore wing (fig. 21) and hind wing (fig. 22) hyaline, veins brown.

Morphology. IO:D = 3.5. Head rounded. Clypeus and labrum as in female. Ocelli on raised tubercle. Epicranial suture distinct. Wings elongate, narrow. In fore wing (fig. 21) veins rs and m fused for short length, venation as in *Caecilius*, vein cu_2 setose; pterostigma and areola postica long, narrow; radial fork approximately same length as stem. Hind wing (fig. 22) with vein cu_1 curved toward wing margin. Tibiae of uniform width, swellings absent. Mesothoracic precoxal suture absent. Epiproct (fig. 23) trianguloid. Paraproct (fig. 23) with round field 19 trichobothria, bifid projection on posterior margin small, lying between 2 large setae. Small fields of papillae on epiproct and paraproct absent. Hypandrium (fig. 24) a simple shallow lobe, well sclerotised, posterolateral margins with field of large setae. Phallosome (fig. 25) with feebly developed endophallus.

Dimensions. B 1.8, FW 3.01, HW 2.36, F 0.47, T 0.79, t_1 0.190, t_2 0.126, rt 1.5:1, ct 10.0, f_1 0.395, f_2 0.284.

Etymology. Named for our friend and colleague, the late Peter Rawlinson, a specialist on the ecology and biogeography of reptiles of the Bass Strait region.

Clinocaecilius gen. nov.

Diagnosis. With the characters of the tribe plus the following: vein cu_2 of fore wing glabrous; single abdominal vesicle present.

Etymology. The generic name is a combination of the Latin *clino*, to bend, recline, or lean over, and *Caecilius*, a genus of Caeciliidae.

Clinocaecilius edwardsi sp. nov.

Figures 26–29

Material examined. Holotype ♂: Tasmania, Ferntree, in rolled bark, 19 Oct 1962. 5♂ paratypes: same data as holotype (V. V. Hickman). Additional material (1♂): Tunbridge, Steppes Rd, *Bedfordia salicina*, 13 Nov 1986.

Description of male. *Coloration* (after ca 30 years in alcohol). Head pale brown with suggestion of darker markings as follows: dorsal to eyes, across back of vertex and each side of median epicranial suture; central patch on frons; postclypeal striae. Ocelli pale, tubercle dark brown. Eyes greyish-black. Fore wing (fig. 26) and hind wing (fig. 27) with faint brown tinge,

veins brown. Thorax brown, legs and abdomen pale brown.

Morphology. IO:D = 2.7. Ocelli large, on prominent tubercle. Median epicranial suture distinct. Clypeal shelf broad. Labrum: stylets small, spiculate; internal sclerotisation not distinct; sensilla 5 in total. Lacinia apically broad, preapically expanded on one side, apical margin with denticles. Setae on fore wing (fig. 26) veins in single rank, short, slanting distally; vein cu_2 glabrous; pterostigma elongate; areola postica elongated, narrow; junction of veins rs and m variable from fusion for a short length, meeting at a point or joined by short cross-vein. Mesothoracic precoxal suture absent, sterna very broad. One ventral abdominal adhesive vesicle present. Epiproct triangular, with short setae in apical half. Paraproct with oval field of about 22 trichobothria. Hypandrium (fig. 28, paratype) setose, with 2 large median preapical setae. Phallosome (fig. 29) rounded anteriorly, aedeagus bluntly pointed, endophallic lobe spiculate.

Dimensions. B 2.3, FW 3.25, HW 2.51, F 0.61, T 0.98, t_1 0.253, t_2 0.095, rt 2.7:1, ct 17.0, f_1 0.474, f_2 0.355.

Female. Unknown.

Remarks. The genitalia of this species grossly resemble those of *Bassocaecilius rawlinsoni* in the shape of the phallosome and by the absence of papillae on the epiproct and paraproct. *Clinocaecilius edwardsi* differs, however, by the hypandrium possessing a pair of large median preapical setae.

Etymology. Named for Barry A. B. Edwards, in recognition of his pioneering synopsis of the Tasmanian Psocoptera.

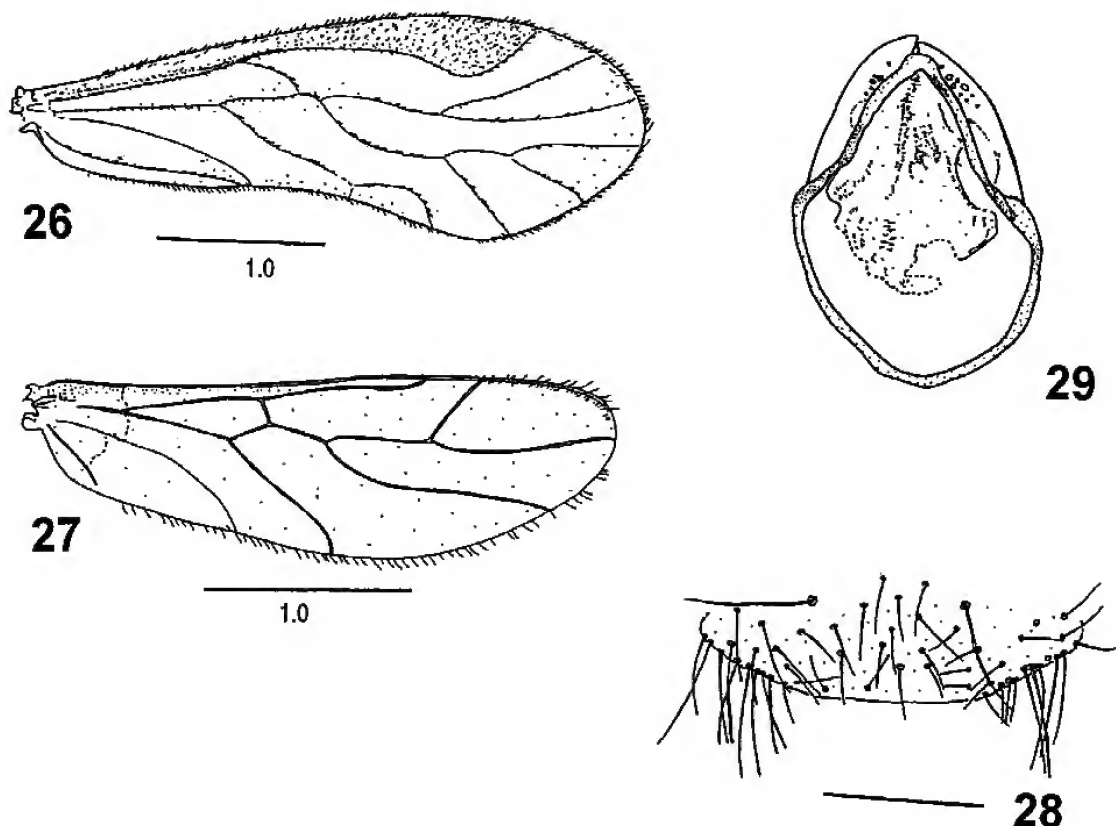
Maoripsocini Mockford

Maoripsocus Tillyard

Maoripsocus Tillyard, 1923: 191. Type species: *Maoripsocus semifuscatus* Tillyard.

Key to Tasmanian species of *Maoripsocus*

1. Micropterous *pedderi* sp. nov.
- Macropterous 2
2. Fore wing membrane with setae *tahunensis* sp. nov.
- Fore wing membrane without setae 3
3. Fore wing basal veins with two ranks of setae 4
- Fore wing basal veins with single rank of setae 6
4. Postclypeus with distinct striae *semifuscatus* Tillyard
- Postclypeus uniformly brown 5
5. Head pattern with dark X-mark centred on ocellar protuberance, fore wing with pterostigmal spur-vein *juneae* (Schmidt and Thornton)
- Head pattern lacking dark X-mark centred on ocellar protuberance, fore wing lacking pterostigmal spur-vein *concastigma* (Schmidt and Thornton)
6. Lacinia basally spiraloid *spiralosus* sp. nov.



Figures 26-29. *Clinocaecilius edwardsi*. Male: 26, fore wing; 27, hind wing; 28, hyandrium; 29, phallosome. Figures 28 and 29 to common scale.

- Lacinia not basally spiraloid 7
- 7. Fore wing with apices of cells R_1 , R_3 and R_5 pigmented
..... *hobartensis* sp. nov.
- Fore wing with apices of cells R_1 , R_3 and R_5 hyaline 8
- 8. ♀ IO:D = 3.8, ♂ IO:D = 2.5 *wedgei* sp. nov.
- ♀ IO:D = 2.7, ♂ IO:D = 0.8 *weindorferi* sp. nov.

Remarks. Mockford (2000) considered this genus to possess a clypeal shelf that is narrow in development. We consider that it is somewhat intermediate in development as it is broader than the narrow clypeal shelf found in genera placed in the Epicaeciliini below.

Maoripsocus concavistigma (Schmidt and Thornton)

Caecilius concavistigma Schmidt and Thornton, 1993: 149.
Maoripsocus concavistigma. --- Mockford, 2000: 345.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Victoria and New South Wales.

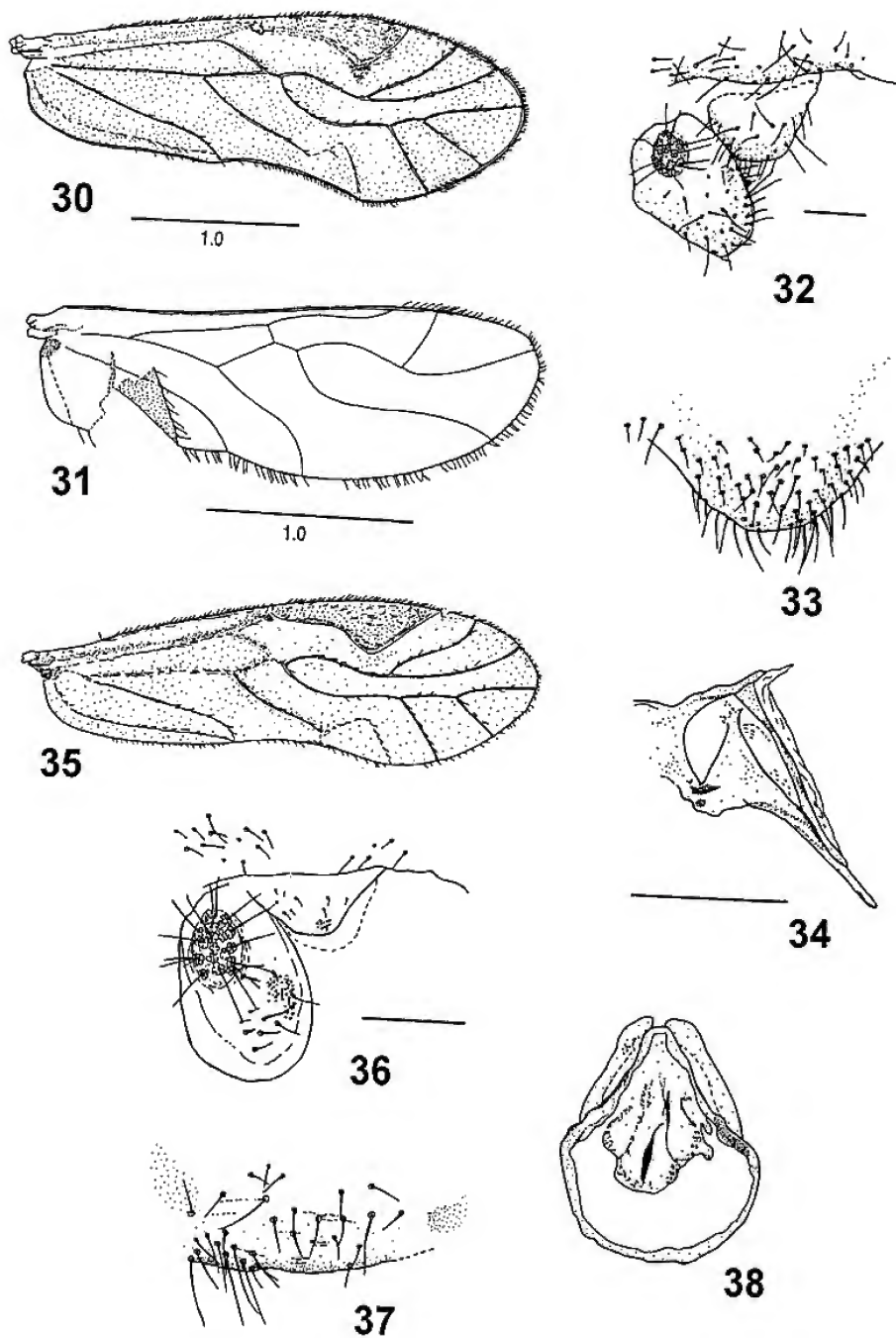
Remarks. This species is widespread in Tasmania. Except for a few individuals found on *Banksia serrata*, *M. concavistigma* was taken only on *Acacia melanoxylon* and *Myoporum insulare*.

Maoripsocus hobartensis sp. nov.

Figures 30–38

Material examined. Holotype ♀: Tasmania, Queens Domain, Hobart, *Bursaria* sp., 23 Mar 1961. One ♂ and 4 ♀ paratypes: same data as holotype (V. V. Hickman).

Description of female. **Coloration** (after ca 32 years in alcohol). Head buff with the following dark brown: markings dorsal to eyes, across back of vertex and each side of median epicranial suture, central region of frons, close-set postclypeal striae,



Figures 30-38. *Maoripsocus hobartensis*. Female: 30, fore wing; 31, hind wing; 32, epiproct and paraproct; 33, subgenital plate; 34, gonapophyses. Male: 35, fore wing; 36, epiproct and paraproct; 37, hypandrium; 38, phallosome. Figures 31, 35; 32, 33 and 36-38 to common scales.

labrum, antenna and two apical segments of maxillary palp. Centripetal margins of ocelli and eyes black. Fore wing (fig. 30) suffused with shades of brown. Hind wing (fig. 31) with slight brown tinge. Thoracic dorsum dark brown, remainder of thorax brown, sutural areas paler. Legs brown except pale brown femora. Abdomen pale mauve dorsally, cream ventrally, terminal segments brown.

Morphology. IO:D = 2.8. Median epicranial suture distinct. Basal flagellar segment slightly bent. Labrum: stylets small, spiculate; sensilla 5 in all; internal sclerotisation present. Lacinia apically broad, preapically expanded on one side, apical margin with denticles. Mesothoracic precoxal suture absent. Fore wing (fig. 30) strongly setose, setae short, slanting distally in a single rank; vein cu_2 setose; short spur-vein from pterostigma present. Epiproct (fig. 32). Paraproct (fig. 32) with round field of 14 trichobothria, posterior margin with small bifid projection and associated seta lying between a short and long seta. Subgenital plate (fig. 33) with transverse margin, two pigmented arms diverging anteriorly from apical margin. Gonapophyses (fig. 34).

Dimensions. B 2.85, FW 2.89, HW 2.27, F 0.56, T 1.0, t_1 0.308, t_2 0.134, rt 2.3:1, ct 17.0, f_1 0.458, f_2 0.316.

Description of male. Coloration (after ca 32 years in alcohol). Head, thorax and legs dark brown. Fore wing as in fig. 35, hind wing as female. Abdomen cream, terminal segments dark brown.

Morphology. IO:D = 2.3. Eyes small, not reaching top of vertex in lateral aspect. Median epicranial suture distinct. Labrum and lacinia as female. Fore wing (fig. 35) as female, except spur-vein from pterostigma absent. Epiproct and paraproct (fig. 36) with small field of papillae, latter with round field of about 22 trichobothria. Hypandrium (fig. 37, torn) with posterolateral group of large setae each side of median area. Phallosome (fig. 38) with blunt-tipped aedeagus, endophallus with 3 membranous lobes.

Dimensions. B 1.7, FW 2.24, HW 1.77, F 0.48, T 0.77, t_1 0.237, t_2 0.103, rt 2.3:1, ct 14.0, f_1 0.355, f_2 0.205.

Remarks. This species is similar to *M. spirilosus* (below) and *M. weindorferi* (below) in features of coloration, genitalia and in the distribution of setae on the fore wing. It differs from *M. spirilosus* (males unknown) in the shape of the basal half of the lacinia. The absence of dark brown pigment in the apical part of the pterostigma of *M. hobartensis* differentiates it from *M. spirilosus* and *M. weindorferi*, but this character is known to vary in other species (e.g. *M. semifuscatus* and *M. wedgei* below). *M. hobartensis* lacks the small distinct hyaline areas in cells *An* and *Cu* found in the other two species.

Etymology. Referring to the type locality, Hobart.

Maoripsocus juneae (Schmidt and Thornton)

Caecilius juneae Schmidt and Thornton, 1993: 152.

Caecilius sp. RF. Coy et al., 1993: 77.

Maoripsocus juneae. --- Mockford, 2000: 346.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania and Victoria.

Remarks. *M. juneae* is locally widespread and was most common in rainforest habitats of *Nothofagus* and the conifers, those of mixed forest and in some cases in wet forest. Within dry forest it was found mainly on *Banksia serrata*.

Maoripsocus pedderi sp. nov.

Figures 39–44

Material examined. Holotype ♀: Tasmania, South Cape Rivulet, coastal scrub, 29 Mar 1988.

Description of female. Coloration (after ca 4.5 years in alcohol). Head dark brown, with the following brown: large patch on crest of vertex each side of median epicranial suture, broad band on vertex adjacent to epistomal suture extending across front of head to antennal socket, gena and antenna. Maxillary palps brown, terminal segment dark brown. Ocelli pale, centripetal margins black. Eyes black. Fore wing (fig. 39) brown, apex pale. Meso- and meta-thoracic terga with small dorsal median cream patch, remainder of thorax and legs brown. Abdomen cream, terminal segments brown.

Morphology. IO:D = 4.0. Head glossy. Postclypeal striae not obvious. Labrum: stylets small, spiculate; sensilla 5 in total; internal sclerotisation present. Lacinia (fig. 40) broad, preapically strongly expanded on one side, apical margin denticulate, strongly bent mid way. Antennal flagellar segments extremely short. Micropterous. Fore wing (fig. 39): vein cu_2 glabrous; apex narrowing; microtrichia on wing margin obvious, reduced at apical region of wing; anterior wing margin lacking setae. Hind wing a small rudiment. Presence of abdominal adhesive vesicles not known. Epiproct (fig. 41) setose. Paraproct (fig. 41) with small sclerotised cone and adjacent macroseta on posterior margin, a round field of 14 trichobothria. Subgenital plate (fig. 42) apically emarginate with lateral apophyses; posterior region bearing larger setae than remainder of plate; sclerotised pigment band with pair of anteriorly diverging arms. Gonapophyses (fig. 43) with external valve remnant represented by one seta. Spermatheca (fig. 44) with long glandular area, sac large and well sclerotised.

Dimensions. B 2.4, FW 0.50, F 0.58, T 0.90, t_1 0.284, t_2 0.118, rt 2.4:1, ct 0.0, f_1 0.300, f_2 0.197.

Male. Unknown.

Remarks. Known only from a single specimen, this species is distinctive in that vein cu_2 of the forewing is glabrous. In all other characters it agrees with *Maoripsocus*, and thus is tentatively placed here.

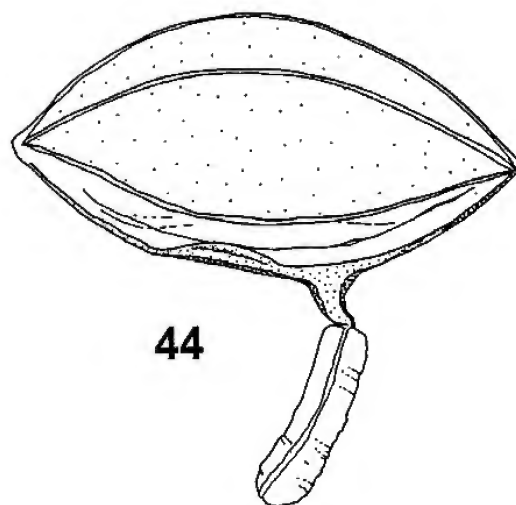
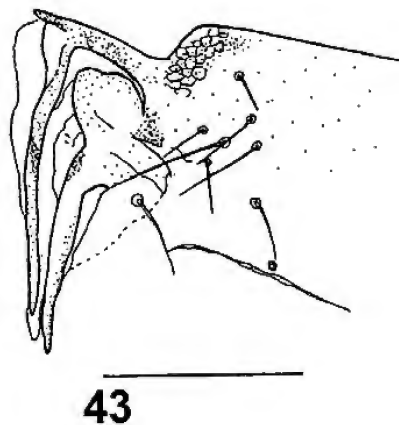
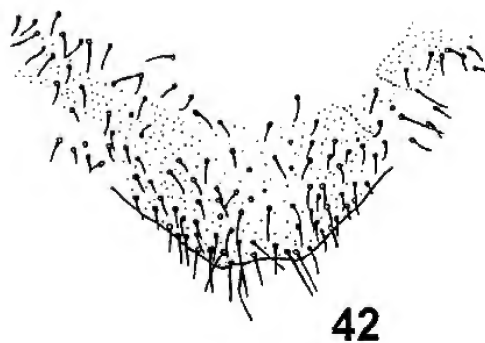
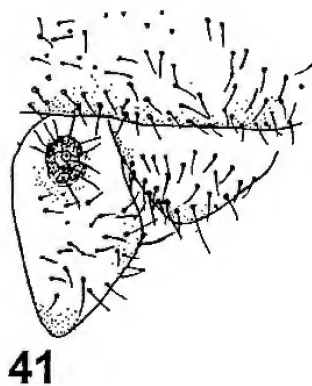
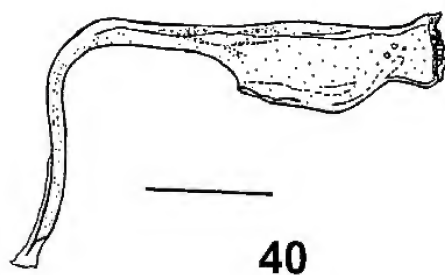
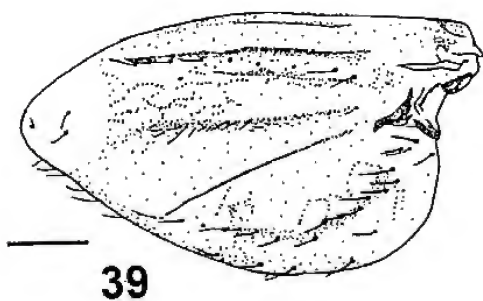
Etymology. Named for Sir John L. Pedder, the first Chief Justice of Tasmania.

Maoripsocus semifuscatus Tillyard

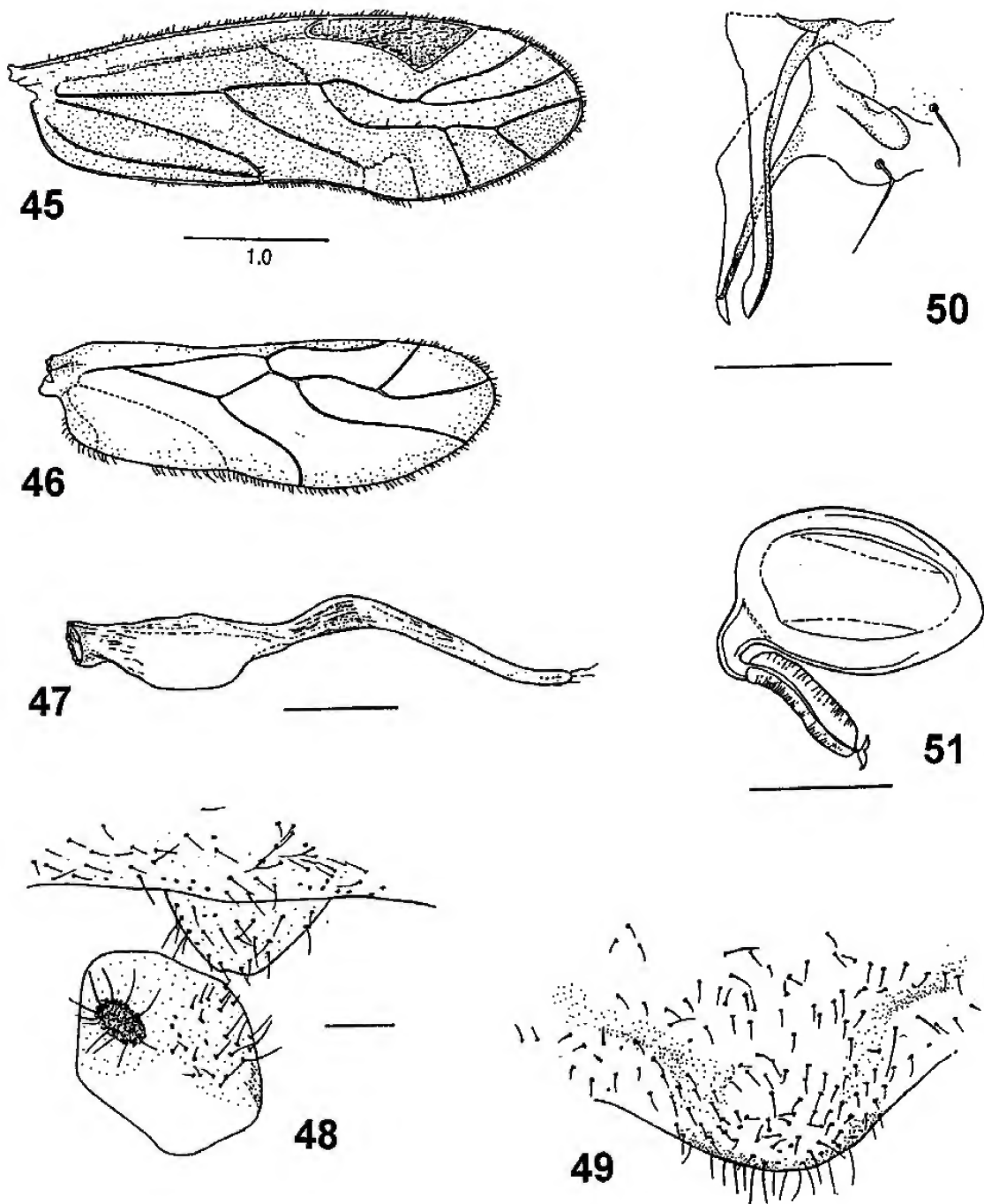
Maoripsocus semifuscatus Tillyard, 1923: 191.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales, South Australia and New Zealand.



Figures 39-44. *Maoripsocus pedderi*. Female: 39, fore wing; 40, lacinia; 41, epiproct and paraproct; 42, subgenital plate; 43, gonapophyses; 44, spermathecal sac. Figures 39, 41, 42 and 43 and 44 to common scales.



Figures 45-51. *Maoripsocus spirilosus*. Female: 45, fore wing; 46, hind wing; 47, lacinia; 48, epiproct and paraproct; 49, subgenital plate; 50, gonapophyses; 51, spermathecal sac. Figures 45, 46 and 48 and 49 to common scales.

Remarks. This widespread species was found at many sites (some with dead foliage), but predominated in those of dry coastal scrub in the northern part of the state, and wet coastal scrub in the south. In dry forest the species was numerous on *Banksia serrata*.

***Maoripsocus spiralosus* sp. nov.**

Figures 45–51

Material examined. Holotype ♀: Tasmania, Lyell Hwy, *Hakea epiglottis*, 16 Nov 1986.

Description of female. Coloration (after ca 6 years in alcohol). Head brown, with the following dark brown: markings dorsal to eyes, across back of vertex and each side of median epicranial suture, median area of frons, postclypeal striae, two apical segments of maxillary palp, centripetal margins of ocelli, antenna. Eyes black. Fore wing (fig. 45) with brown markings and small hyaline areas. Hind wing (fig. 46) with slight brown tinge. Thoracic dorsa dark brown, remainder of thorax and legs brown. Abdomen cream, terminal segments brown.

Morphology. IO:D = 3.3. Basal flagellar segment slightly bent. Labrum: stylets small, spiculate; internal sclerotisation present; 5 distal sensilla. Lacinia (fig. 47) apically broad, preapically expanded on one side, apical margin with denticles, basally spiral-shaped. Mesothoracic precoxal suture absent. Setae on fore wing (fig. 45) veins short in single rank, slanting distally; vein cu_2 strongly setose. Epiproct and paraproct (fig. 48). Subgenital plate (fig. 49) rounded posteriorly, pigment area broad medially, with two slender arms diverging anteriorly. Gonapophyses (fig. 50) with external valve remnant bearing a single seta. Spermatheca (fig. 51) with long glandular area, sac large and well sclerotised.

Dimensions. B 2.9, FW 3.30, HW 2.60, F 0.71, T 1.21, t_1 0.324, t_2 0.134, rt 2.4:1, ct 19:0, f_1 0.577, f_2 0.348.

Male. Unknown.

Remarks. In details of the distribution of setae on the fore wing and genitalia this species closely resembles *M. weindorferi* (below). It differs in the shape of the basal half of the lacinia, and in the more extensive pigmentation of the fore wing. The dark brown pigment in the pterostigma is almost entire in *M. spiralosus*, and brown pigment is present basally in cell R_1 and apically in cell R_5 . In *M. weindorferi* the dark brown pigment is limited to the apical half of the pterostigma; cell R_1 and the apical part of cell R_5 are hyaline.

Etymology. The specific name refers to the unusual form of the lacinia.

***Maoripsocus tahunensis* sp. nov.**

Figures 52–56

Material examined. Holotype ♀: Tasmania, Franklin – Gordon Wild Rivers National Park, Tahune Lake, 7 Mar 1988.

Description of female. Coloration (after ca 4 years in alcohol). Head brown with the following dark brown: broad band dorsal to eyes extending across centre of vertex, centripetal margins

of ocelli, central region of frons, postclypeal striae, antenna and narrow band from antennal socket half way around ventral margin of eye. Eyes black. Fore wing (fig. 52) brown with hyaline patches. Hind wing (fig. 53) with brown tinge. Thorax dark brown, sutural lines nearly black. Legs brown except pale trochanters and dark brown claws. Abdomen dorsally pale mauve, cream ventrally. Terminal segments brown.

Morphology. IO:D = 4.2. Clypeal shelf intermediate in development. Basal flagellar segment bent. Labrum: stylets small, spiculate; distal sensilla 5 in all, internal sclerotisation present. Lacinia broad, flat, expanded preapically on one side with apical denticles. Postclypeal striae not quite reaching anterior margin. In basal half of fore wing, setae on veins in 2 ranks: cu_2 setose; setae on membrane basally in cell M_3 , in cell cu_2 and at apex of cell cu_1 (the latter in one wing only). On one fore wing vein M_3 absent and areola postica joined to media by cross-vein. Spur-vein from pterostigma present. Mesothoracic precoxal suture absent. Presence of abdominal adhesive vesicles not known. Epiproct setose, apical fifth not sclerotised and bearing 3 small setae on posterior margin. Paraproct setose with oval field of 17 trichobothria. Subgenital plate (fig. 54) with transverse posterior margin, pigmented band with pair of anteriorly diverging arms. Gonapophyses (fig. 55) with external valve remnant as one or two setae. Spermatheca (fig. 56) with long glandular area, sac large and sclerotised.

Dimensions. B 2.2, FW 2.68, HW 2.2, F 0.63, T 1.04, t_1 0.292, t_2 0.126, rt 2.3:1, ct 0.0, f_1 0.474, f_2 0.308.

Male. Unknown.

Remarks. This species is similar to species of *Kodamaius* Okamoto in possessing setae on the fore wing membrane, a pterostigmal spur-vein, long setae on the basal veins in 2 ranks and vein cu_2 strongly setose. In *M. tahunensis* veins rs and m of the fore wing are fused for a short distance, in *Kodamaius* they are joined by a cross-vein.

Only a single specimen of this species is known, and until further material can be studied it is presently retained in *Maoripsocus*.

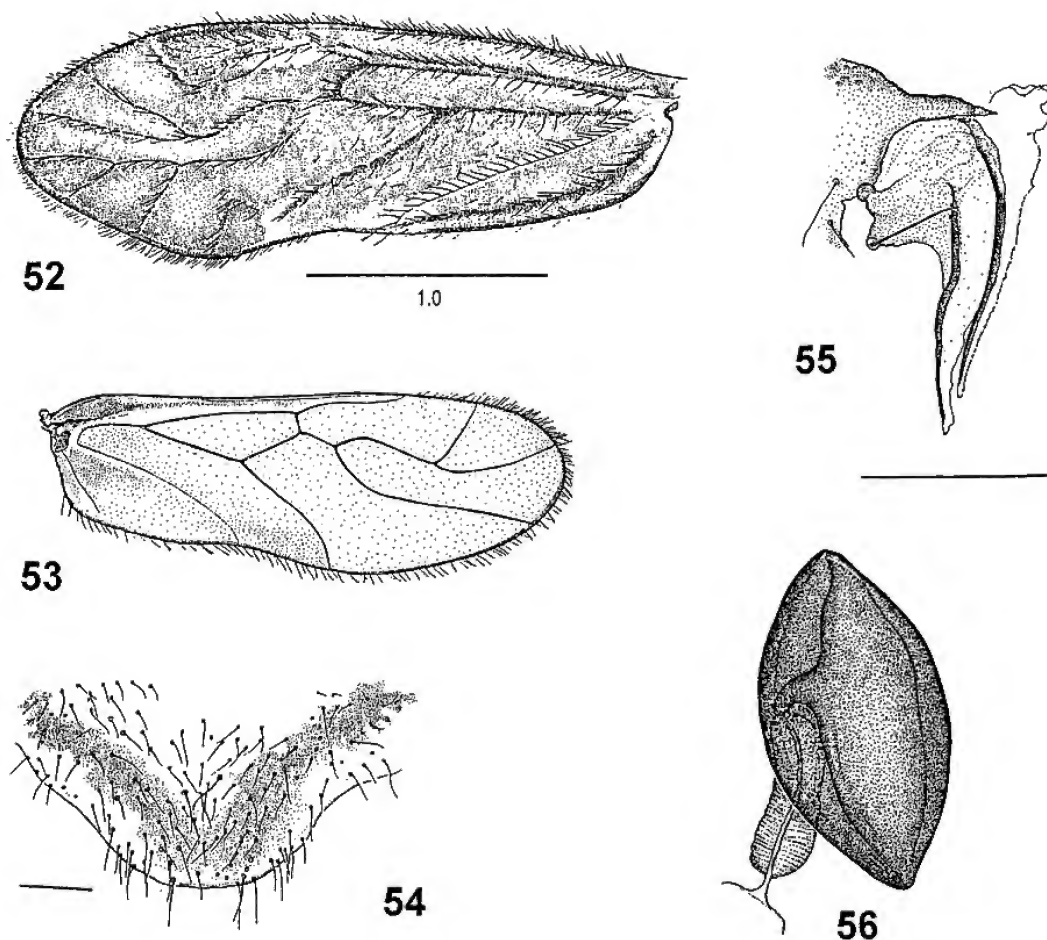
Etymology. Referring to the type locality, Tahune Lake.

***Maoripsocus wedgei* sp. nov.**

Figures 57–65

Material examined. Holotype ♀: Tasmania, Cradle Mtn - Lake St Clair National Park, Weindorfers Forest, *Athrotaxis selaginoides*, 26 Nov 1986. Four ♀ and 5 ♂ paratypes: same data as holotype. Additional records: **site** 179B, 2♀, 26 Feb 88; **site** 219A, 1♂, 1 nymph, 26 Nov 86; 1♂, 7 Feb 87; **site** 219C (holotype locality), 5♀, 5♂, 26 Nov 86; **site** 219D, 12♀, 24♂, 2 nymphs, 27 Nov 86; 1♀, 7 Feb 87; **site** 219E, 1♂, 26 Nov 86; **site** 219F, 10♀, 3♂, 27 Nov 86; 4♀, 23 Jan 87; 3♀, 7 Feb 87; 1♀, 2 Mar 87; **site** 219G, 1♀, 1 nymph, 23 Jan 87; **site** 221, 6♀, 9♂, 4 nymphs, 27 Nov 86.

Description of female. Coloration (after ca 6 years in alcohol). Head pale brown with the following brown: markings dorsal to eyes, across back of vertex, along median epicranial suture, ocellar region, frons, striae on postclypeus, antenna and labrum. Maxillary palpi brown, apical segment darker. Centripetal margins of ocelli and eyes black. Thorax dark brown, paler



Figures 52-56. *Maoripsocus tahunensis*. Female: 52, fore wing; 53, hind wing; 54, subgenital plate; 55, gonapophyses; 56, spermathecal sac. Figures 52, 53 and 55 and 56 to common scales.

ventrally, sutural lines dark. Fore wing (fig. 57) light brown with hyaline areas, hind wing (fig. 58) hyaline. Legs: coxae, tibiae and tarsi brown, claws black, femora pale brown merging brown apically. Abdomen pale mauve dorsally, slightly paler ventrally. Terminal segments brown.

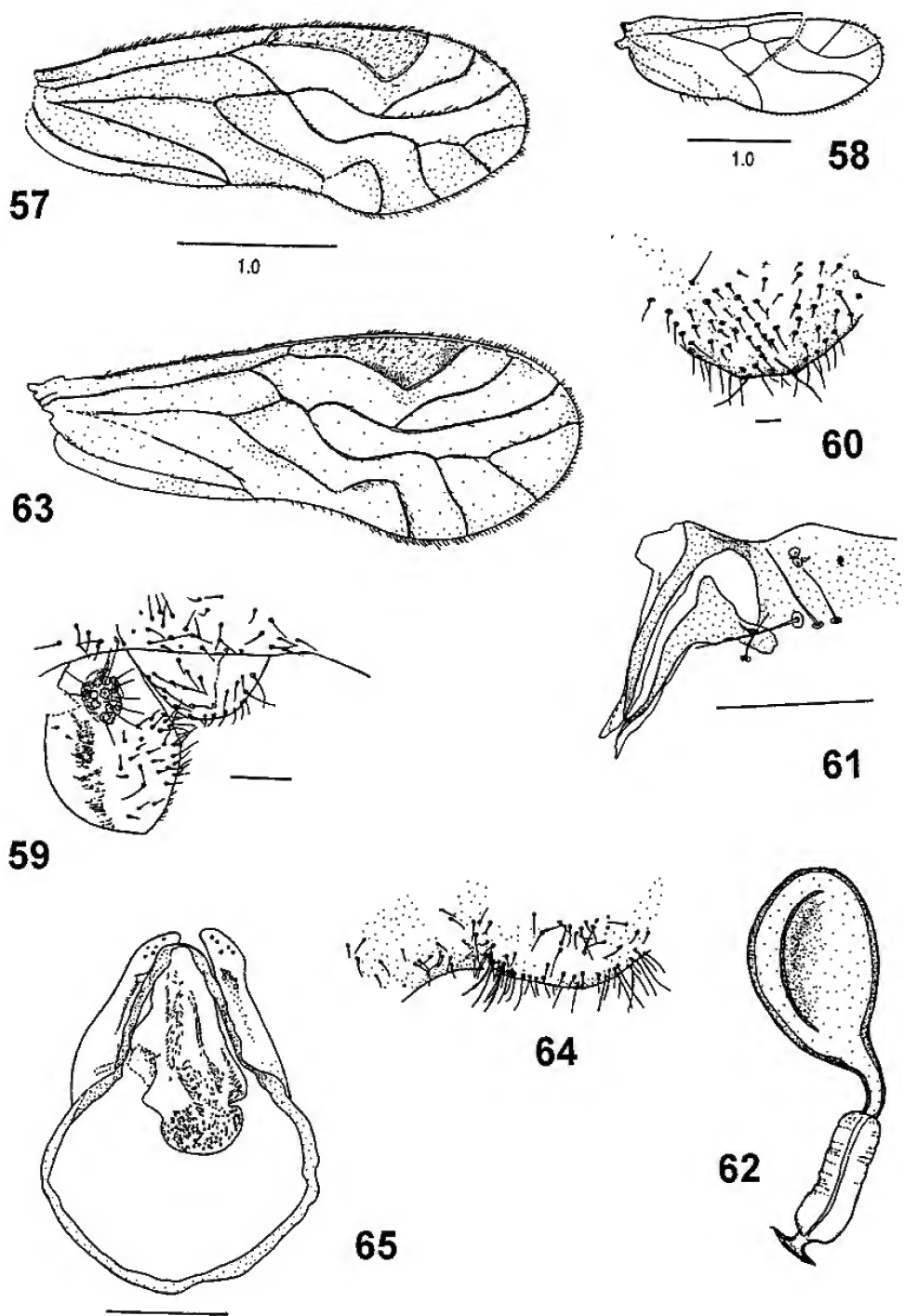
Morphology. IO:D = 3.8. Median epicranial suture distinct. Basal flagellar segment not enlarged, slightly bent. Labrum: stylets small, spiculate; distal anterior margin with 5 sensilla; internal sclerotisation present. Lacinia broad, flat, expanded preapically on one side, with apical denticles. Mesothoracic precoxal suture absent. Setae on fore wing (fig. 57) veins short, in single rank, slanting distally; vein cu_2 of fore wing setose. Abdomen with two eversible vesicles. Epiproct (fig. 59)

semicircular, setose. Paraproct (fig. 59) with rounded field of 16 trichobothria. Subgenital plate (fig. 60): simple, setose, with median transverse margin; single large seta at each posterolateral margin; sclerotised pigment arms diverging anteriorly. Gonapophyses (fig. 61). Spermatheca (fig. 62) with long glandular area, sac moderately large and sclerotised.

Dimensions. B 2.5, FW 2.80, HW 2.24, F 0.61, T 1.06, t_1 0.308, t_2 0.142, rt 2.2:1, ct 21.0, f_1 0.474, f_2 0.269.

Description of male. *Coloration* (after ca 6 years in alcohol). As in female. Fore wing pigmented as in fig. 63, hind wing hyaline.

Morphology. IO:D = 2.5. Eyes small, not reaching top of vertex when looking at side of head. Median epicranial suture distinct. Labrum and lacinia as female. Tibiae of uniform



Figures 57-65. *Maoripsocus wedgei*. Female: 57, fore wing; 58, hind wing; 59, epiproct and paraproct; 60, subgenital plate; 61, gonapophyses; 62, spermathecal sac. Male: 63, fore wing; 64, hypandrium; 65, phallosome. Figures 57, 63; 59, 64 and 61 and 62 to common scales.

width, swellings absent. Mesothoracic precoxal suture absent. Epiproct and paraproct with small fields of papillae, latter with oval field of 26 trichobothria. Hypandrium (fig. 64) simply rounded, posterolateral margins with field of strong setae. Phallosome (fig. 65).

Dimensions. B 2.3, FW 2.98, HW 2.36, F 0.66, T 1.17, t_1 0.355, t_2 0.150, rt 2.4:1, ct 21.0, f_1 0.624, f_2 0.387.

Remarks. *M. wedgei* was found mainly on *Nothofagus* and conifer rainforest habitats at Cradle Mountain. This species is similar to *M. semifuscatus* in details of genitalia and fore wing pigmentation. Considerable variation occurs in the extent of fore wing pigmentation (light brown to prominent dark brown pattern), particularly in the pterostigma. The fore wing of *M. semifuscatus* is densely setose, and veins *r* and *an* have two incipient rows of setae. The fore wing of *M. wedgei* is more sparsely setose, and all veins have a single row of setae. The eyes of males of *M. semifuscatus* (IO:D = 1.1, eyes are level with the top of the vertex when looking at the side of the head) are larger than those of *M. wedgei*.

M. wedgei is a seasonal species, being found only from November to March.

Etymology. Named for John H. Wedge, an early surveyor and explorer in Tasmania.

Maoripsocus weindorferi sp. nov.

Figures 66–74

Material examined. Holotype ♀: Tasmania, Wilmot, Cradle Mtn Road, dead rainforest material (row from clearing), 17 Mar 1987. One ♂ and 2♀ paratypes: same data as holotype. Additional records: **site** 179A, 1 ♀, 2 nymphs, 18 Mar 1987; **site** 304A, 1♀, 1♂, 29 Nov 1986.

Description of female. **Coloration** (after ca 5 years in alcohol). Ground colour of head pale brown, with brown markings as follows: dorsal to eyes, across back of vertex and each side of median epicranial suture; broad patch centrally on frons; postclypeal striae converging towards midline. Antenna, labrum and two apical segments of maxillary palp dark brown. Ocelli pale, with black centripetal margins. Eyes black. Fore wing (fig. 66) with pattern of hyaline and brown areas. Hind wing (fig. 67) with brown tinge. Thorax and legs dark brown. Abdomen cream with terminal segments brown.

Morphology. IO:D = 2.7. Median epistomal suture distinct. Labrum: stylets spiculate; distal margin with 5 sensilla; internal sclerotisation present. Lacinia broad, flat, expanded preapically on one side, with apical denticles. Setae on flagellar segments short, uniform. Distribution of placoid sensilla: 2 small at base of f_1 , 1 at apices f_4 , f_6 and f_{10} , short filament on latter two placoids. Apex of distal segment narrowing, bluntly rounded. Head and thorax glossy. Mesothoracic precoxal suture absent. Setae on fore wing (fig. 66) in single rank, short and slanting distally; vein cu_2 setose. Abdomen with two ventral eversible vesicles. Epiproct (fig. 68) semicircular, setose. Paraproct (fig. 68) with round field of 16 trichobothria. Subgenital plate (fig. 69) uniformly setose, with pair of anteriorly diverging pigmented arms. Gonapophyses (fig. 70). Glandular area of spermathecal duct long (fig. 71), sac moderately large and sclerotised.

Dimensions. B 2.7, FW 3.01, HW 2.27, F 0.576, T 1.018, t_1 0.308, t_2 0.118, rt 2.6:1, ct 21.0, f_1 0.442, f_2 0.269.

Description of male. **Coloration** (after ca 5 years in alcohol). As female. Fore wing pattern (fig. 72) less intense than that of female.

Morphology. IO:D = 0.8. Eyes large, reaching above top of vertex when looking at side of head. General morphology as in female. Epiproct triangular, setose, with median small field of papillae. Paraproct with ovoid field of 29 trichobothria, and dorsal field of papillae. Hypandrium (fig. 73) sclerotised, posterolateral margins with strong setae. Phallosome (fig. 74).

Dimensions. B 2.2, FW 3.30, HW 2.51, F 0.614, T 1.114, t_1 0.355, t_2 0.126, rt 2.8:1, ct 21, 0, f_1 0.553, f_2 0.332.

Remarks. See those under the descriptions of *M. hobartensis* and *M. spiralosus* (above).

Etymology. Named for Gustav Weindorfer, a conservationist and pioneer of the Cradle Mountain region.

Coryphacini Mockford

Key to Tasmanian genera of Coryphacini

1. Eyes horizontally ovoid, vertex flattened and elongated *Graminacaecilius* gen. nov.
- Eyes and vertex round 2
2. Lacinial tip rounded *Valenzuela* Navas
- Lacinial tip bidentate *Stenocaecilius* Mockford

Graminacaecilius gen. nov.

Diagnosis. With the characters of the tribe Coryphacini (Mockford, 2000) plus the following: anterior labral sensilla distinct; clypeal shelf intermediate in development; eyes horizontally ovoid; labral stylets rudimentary; lacinia narrow, apex rounded; vertex flattened, elongated; subgenital plate with two large preapical setae; hypandrium with two large preapical setae.

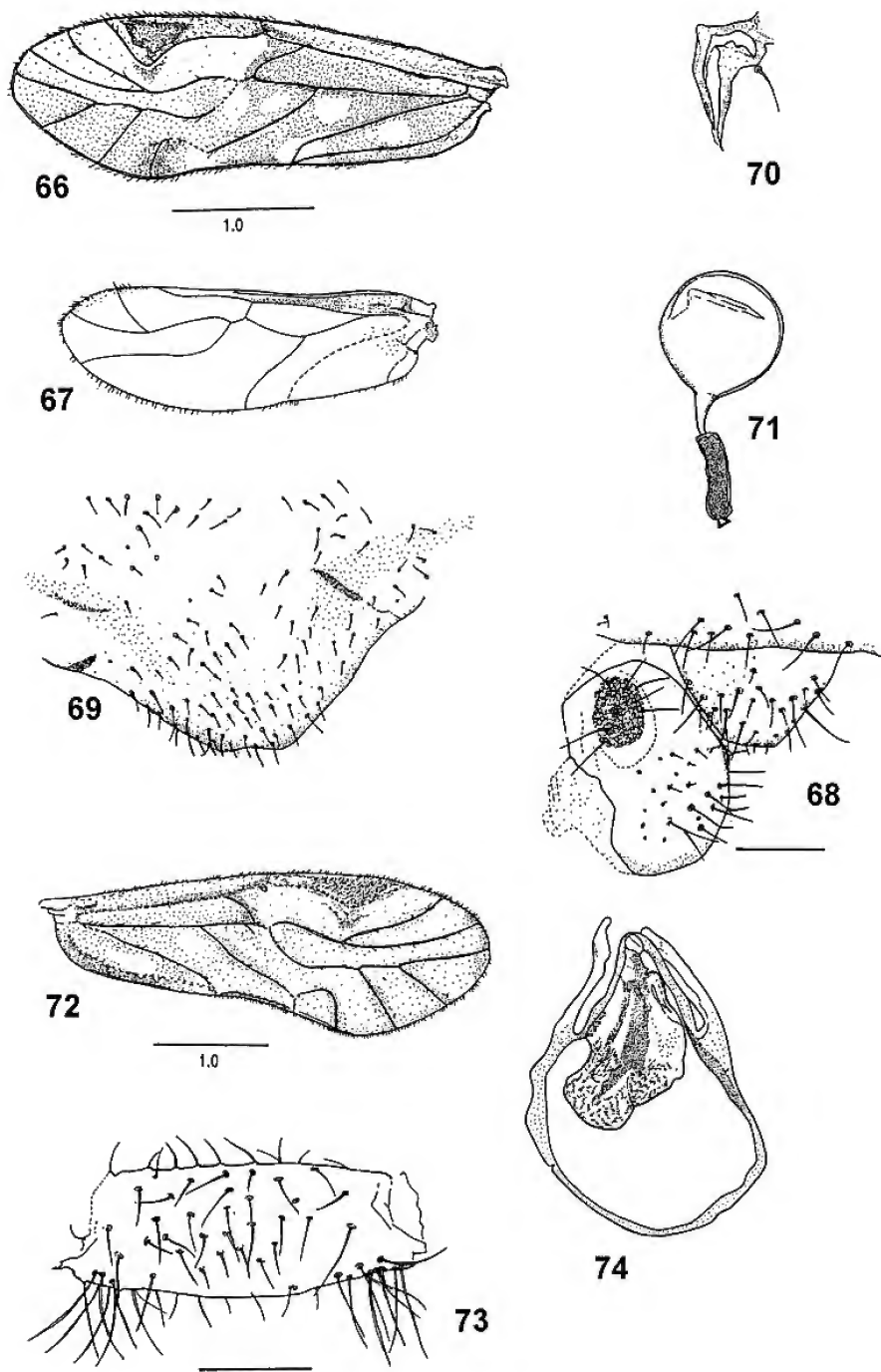
Type species: *Graminacaecilius micropterus* sp. nov.

Remarks. This genus is unusual in the family Caeciliusidae by possessing a distinct row of four large sensilla on the anterior margin of the outer surface of the labrum. This and the combination of other characters listed above are not found in other genera of the subfamily Caeciliusinae. This genus has been included in the Coryphacini even though it possesses an intermediate clypeal shelf.

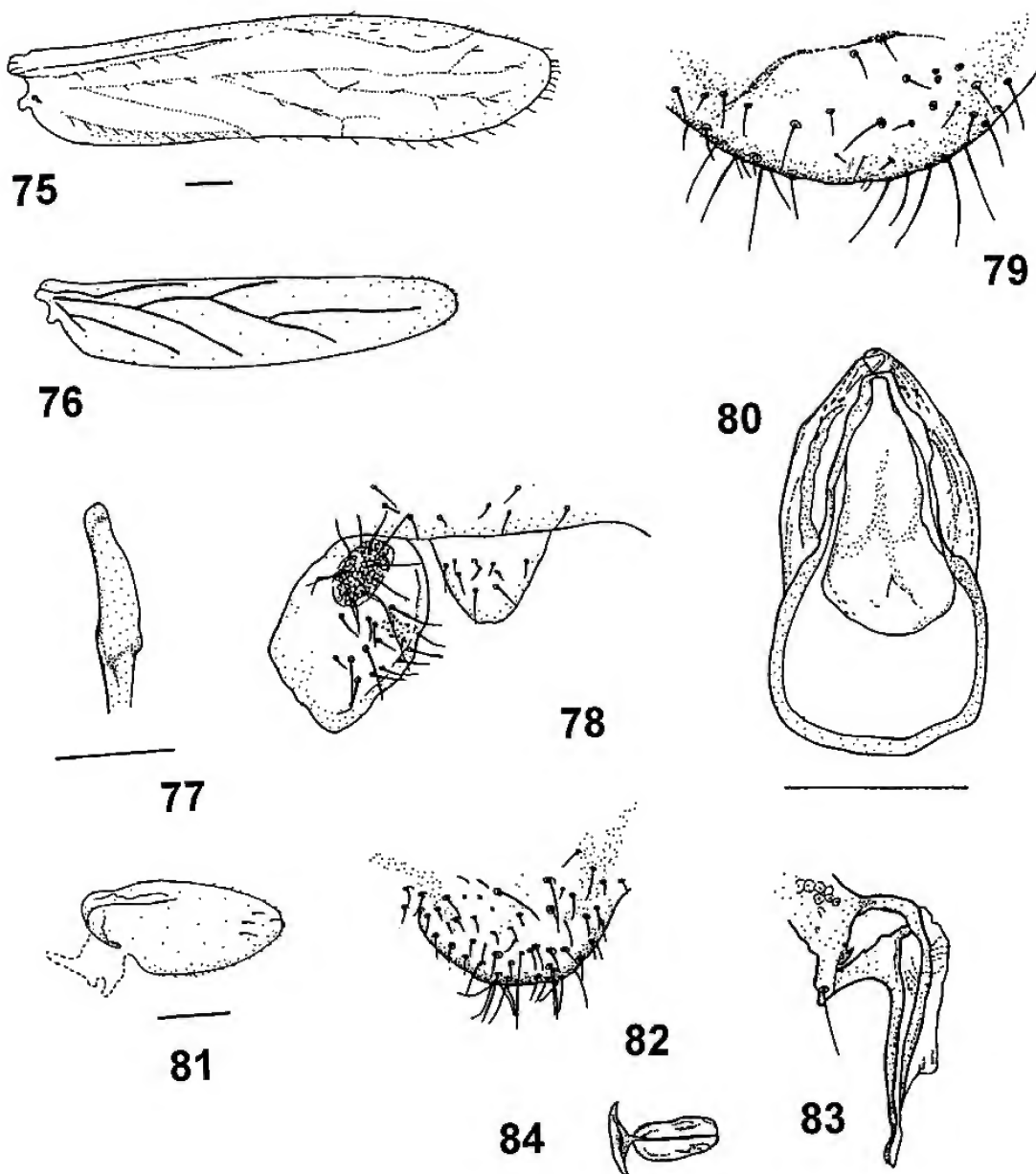
Etymology. The generic name is a combination of the Latin *gramineus*, grass-like, and *Caecilius*, a genus of Caeciliusidae. It refers to the low vegetation habitat of members of this genus.

Key to Tasmanian species of Graminacaecilius

1. Frons without broad brown band *micropterus* sp. nov.
- Frons with broad brown band *frontalis* sp. nov.



Figures 66-74. *Maoripsocus weindorferi*. Female: 66, fore wing; 67, hind wing; 68, epiproct and paraproct; 69, subgenital plate; 70, gonapophyses; 71, spermathecal sac. Figures 66, 67 and 68-71 to common scales. Male: 72, fore wing; 73, hypandrium; 74, phallosome. Figures 73 and 74 to common scale.



Figures 75-84. *Graminacaecilius micropterus*. Male: 75, fore wing; 76, hind wing; 77, lacinia; 78, epiproct and paraproct; 79, hypandrium; 80, phallosome. Female: 81, fore wing; 82, subgenital plate; 83, gonapophyses; 84, spermathecal duct. Figures 75, 76; 77-79; 80, 83, 84 and 81 and 82 to common scales.

Graminacaecilius micropterus sp. nov.

Figures 75–84

Material examined. Holotype ♂: Tasmania, Jackeys Marsh (east), *Carex appressa*, 12 Nov 1986. Eleven nymphs, 20♀ and 22♂ paratypes: same data as holotype.

Description of male. Coloration (after ca six years in alcohol). Head testaceous except the following: brown ocellar tubercle; f_1 testaceous basally merging light brown apically, f_2 light brown basally merging dark brown apically, remaining segments dark brown; eyes black. Fore wing (fig. 75) and hind wing (fig. 76) hyaline. Thorax and legs testaceous. Abdomen creamy white.

Morphology. IO:D = 1.8. Eyes ovoid. Ocelli on raised tubercle. Antenna very long, basal segment slightly bent. Head and thorax glossy. Vertex flattened, elongate. Epicranial suture not distinct. Labrum: stylets as rudimentary spiculate bumps; internal sclerotisation present; distal sensilla 5 in total, row of 4 distinct sensilla on anterior margin of outer surface. Lacinia (fig. 77) apically narrow, rounded, preapically broader. Wings brachypterous. Fore wing (fig. 75): venation as in macropterous *Caecilius*, except apices of radial, medial and cubital veins not distinct; setae short, slanting distally, on veins and margin in a single rank; vein cu_2 glabrous. Hind wing (fig. 76) venation as in macropterous wing, except apices of radial veins not distinct; anal vein absent. Microtrichia obvious on the membranes of wings, particularly at apices. Meso- and meta-thorax not strongly developed. Epiproct (fig. 78). Paraproct (fig. 78) with ovoid field of about 11 trichobothria and small field of papillae. Hypandrium (fig. 79): simply rounded, each posterolateral margin with few strong setae; pair of large median preapical setae. Phallosome (fig. 80) relatively elongated and narrow.

Dimensions. B 1.9, FW 1.10, HW 0.85, F 0.59, T 0.86, t_1 0.245, t_2 0.118, rt 2.1:1, ct 0.0, f_1 0.608, f_2 0.458.

Description of female. Coloration (after ca 6 years in alcohol). As male, except brown ocellar tubercle absent, antenna slightly paler than male.

Morphology. IO:D = 2.0. Median epicranial suture distinct. Ocelli present. Labrum and lacinia as male. Abdomen elongated and slender. Fore wing (fig. 81) reduced to small rudiment, with few setae and covered by microtrichia. Hind wing reduced to small bud. Epiproct semicircular, setose. Paraproct with round field of 8 trichobothria. Subgenital plate (fig. 82): apical median area covered by long setae; anteriorly diverging pigment bands faint and short; body of plate with two large preapical setae. Gonapophyses (fig. 83) with external valve remnant bearing a single seta. Spermatheca (fig. 84) with short glandular area (sac not present).

Dimensions. B 2.3, FW 0.25, F 0.50, T 0.77, t_1 0.182, t_2 0.118, rt 1.5:1, ct 0.0, f_1 0.434, f_2 0.332.

Etymology. Refers to the micropterous nature of known specimens.

Graminacaecilius frontalis sp. nov.

Figures 85–90

Material examined. Holotype ♂: Tasmania, Queens Domain, Hobart, tussock grasses, 8 July 1986. One nymph and 2♀ paratypes: same data

as holotype. Additional records: **site** 42A, 1♀, 12 June 86; 1♀, 18 July 86; 3♀, 1♂, 4 nymphs, 2 Oct 86; **site** 42B, 1♀, 1♂, 18 July 86; **site** 73, 2♀, 1♂, 25 Apr 87; **site** 158, 1♂, 12 Oct 86; 1♀, 25 July 87.

Description of male. Coloration (after ca 6 years in alcohol). Body creamy white, with the following exceptions: anterior margin of frons with broad brown band; centripetal margins of ocelli dark brown; f_1 light brown, f_2 light brown basally merging to dark brown apically, remaining segments dark brown; eyes black; prothorax with brown pleural stripe.

Morphology. IO:D = 2.2. Eyes ovoid. Median epicranial suture distinct. Ocelli present. Fore wing reduced to a small rudiment, hind wing a small bud. Basal flagellar segment bent. Vertex flattened, elongated. Labrum and lacinia as *G. micropterus*. Epiproct (fig. 85). Paraproct (fig. 85) with small field of papillae and ovoid dome of 10 trichobothria, one seta not in rosette. Hypandrium (fig. 86) median region lacking setae, membranous; posterolateral margins with few strong setae; pair of strong median preapical setae. Phallosome (fig. 87) relatively narrow.

Dimensions. B 2.0, F 0.434, T 0.679, t_1 0.174, t_2 0.111, rt 1.6:1, ct 0.0, f_1 0.395, f_2 0.316.

Description of female. Coloration (after ca 6 years in alcohol). As male.

Morphology. IO:D = 3.0. Median epicranial suture distinct. Apterous. Epiproct strongly setose. Paraproct with large macroseta on posterior margin and small round field of 4 trichobothria. Subgenital plate (fig. 88): apical median area membranous, setae absent; pigmentation barely visible; body of plate setose, pair of preapical setae not as distinct as in *G. micropterus*. Gonapophyses (fig. 89) with external valve remnant bearing a single seta. Spermatheca (fig. 90) with short glandular area.

Dimensions. B 2.5, F 0.427, T 0.671, t_1 0.158, t_2 0.111, rt 1.4:1, ct 0.0, f_1 0.328, f_2 0.217.

Remarks. This species has been found by ERS on the Mornington Peninsula, Victoria.

Etymology. Referring to the strongly marked frons of this species.

Stenocaecilius Mockford

Stenocaecilius Mockford, 2000: 356. Type species: *Stenocaecilius casarum* Badonnel.

Key to Tasmanian species of *Stenocaecilius*

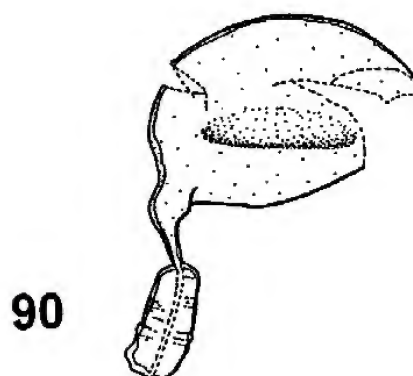
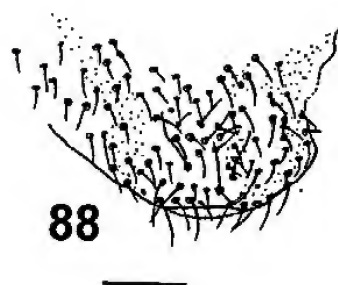
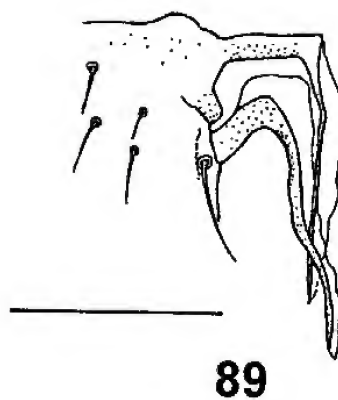
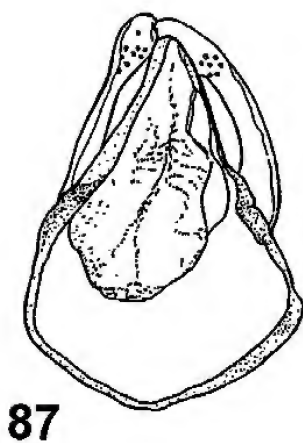
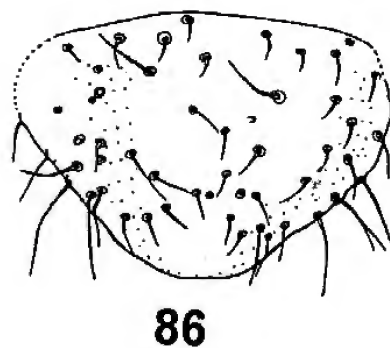
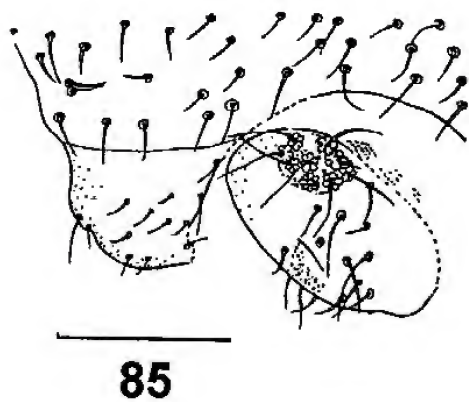
1. Brown mark behind antenna base *quercus* (Edwards)
- No brown mark behind antenna base *lineatus* (Smithers)

Stenocaecilius lineatus (Smithers)

Caecilius lineatus Smithers, 1977: 256.

Stenocaecilius lineatus. --- Mockford, 2000: 357.

Material examined. **Site** 131E, 3♀, 2 nymphs, 24 Feb 88; **site** 137A, 2♀, 3♂, 11 July 86; 1♂, 9 Aug 86; 2 nymphs, 8 Nov 86; 1♀, 23 Mar 87; 3♂, 14 June 87; 1♀, 1♂, 25 July 87; 1♀, 5♂, 3 nymphs, 24 Feb 88.



Figures 85-90. *Graminacaecilius frontalis*. Male: 85, epiproct and paraproct; 86, hypandrium; 87, phallosome. Female: 88, subgenital plate; 89, gonapophyses; 90, spermathecal sac. Figures 85-87 and 89 and 90 to common scales.

Distribution. Tasmania and New South Wales.

Remarks. This species was taken only from *Casuarina littoralis* at two localities.

***Stenocaecilius quercus* (Edwards)**

Caecilius quercus Edwards, 1950: 131.

Stenocaecilius quercus. --- Mockford, 2000: 357.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and Lord Howe I.

Remarks. *S. quercus* was found on a limited number of occasions at many sites. The great majority of individuals were taken from *Myoporum insulare* and *Acacia melanoxylon*. The latter plant species is found in climatic zones ranging from dry forest to rainforest, and on this species *S. quercus* was abundant in dry, swamp and some limited wet forest sites, but was usually absent in wetter mixed forest and rainforest sites.

***Valenzuela* Navas**

Valenzuela Navas, 1924: 20. Type species: *Valenzuela marianus* Navas.

***Valenzuela pteridii* (Smithers)**

Caecilius pteridii Smithers, 1977: 257.

Valenzuela pteridii. --- Mockford, 2000: 353.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and Lord Howe I.

Remarks. This locally widespread species was found on a limited number of occasions on many plant species, particularly those of dry coastal scrub and dry forest, and wet scrub. It was most numerous and taken throughout the year on bracken.

***Epicaeciliini* Mockford**

Key to Tasmanian genera of *Epicaeciliini*

1. Brachypterous, fore wing basal veins with two ranks of setae, vein cu_2 strongly setose *Nothocaecilius* gen. nov.
- Macropterous, fore wing basal veins with one rank of setae, vein cu_2 glabrous *Tasmanocaecilius* gen. nov.

***Nothocaecilius* gen. nov.**

Diagnosis. With the characters of the tribe *Epicaeciliini* (Mockford, 2000) plus the following: clypeal shelf narrow; labral stylets present; abdominal adhesive vesicles absent; brachypterous; setae of fore wing long, standing relatively upright, in at least two ranks on veins in basal half of wing; external valve represented by two or three setae; anterior margin of phallosome transverse; male epiproct with a small papillar field.

Type species: *Nothocaecilius thomasi* sp. nov.

Remarks. The combination of the above characters, particularly those associated with the brachypterous wings, are unique.

Etymology. The generic name is a combination of the Greek *nothos*, spurious, and *Caecilius*, a genus of *Caeciliusidae*. It alludes to the *Nothofagus* rainforest habitat of the type species.

***Nothocaecilius thomasi* sp. nov.**

Figures 91–101

Caecilius sp. C. Coy et al., 1993: 77.

Material examined. Holotype ♀: Mt Michael, 740 m, 41°10.9'S 148°00.4'E, PKD, tree #2, 26 Nov 1989 (H. Mitchell). Paratype ♂: Frodshams Pass, Scotts Peak Road, 1.5 km west Gordon River Road, 42°49'S 146°23'E, fogging *Nothofagus cunninghamii* Sample B, 15 Feb 1990 (R. Coy, P. Lillywhite, A. Yen) (MV). Additional records: 3 ♀, 1 ♂, under stones, Ferntree, 28 May 1957 (V. V. Hickman).

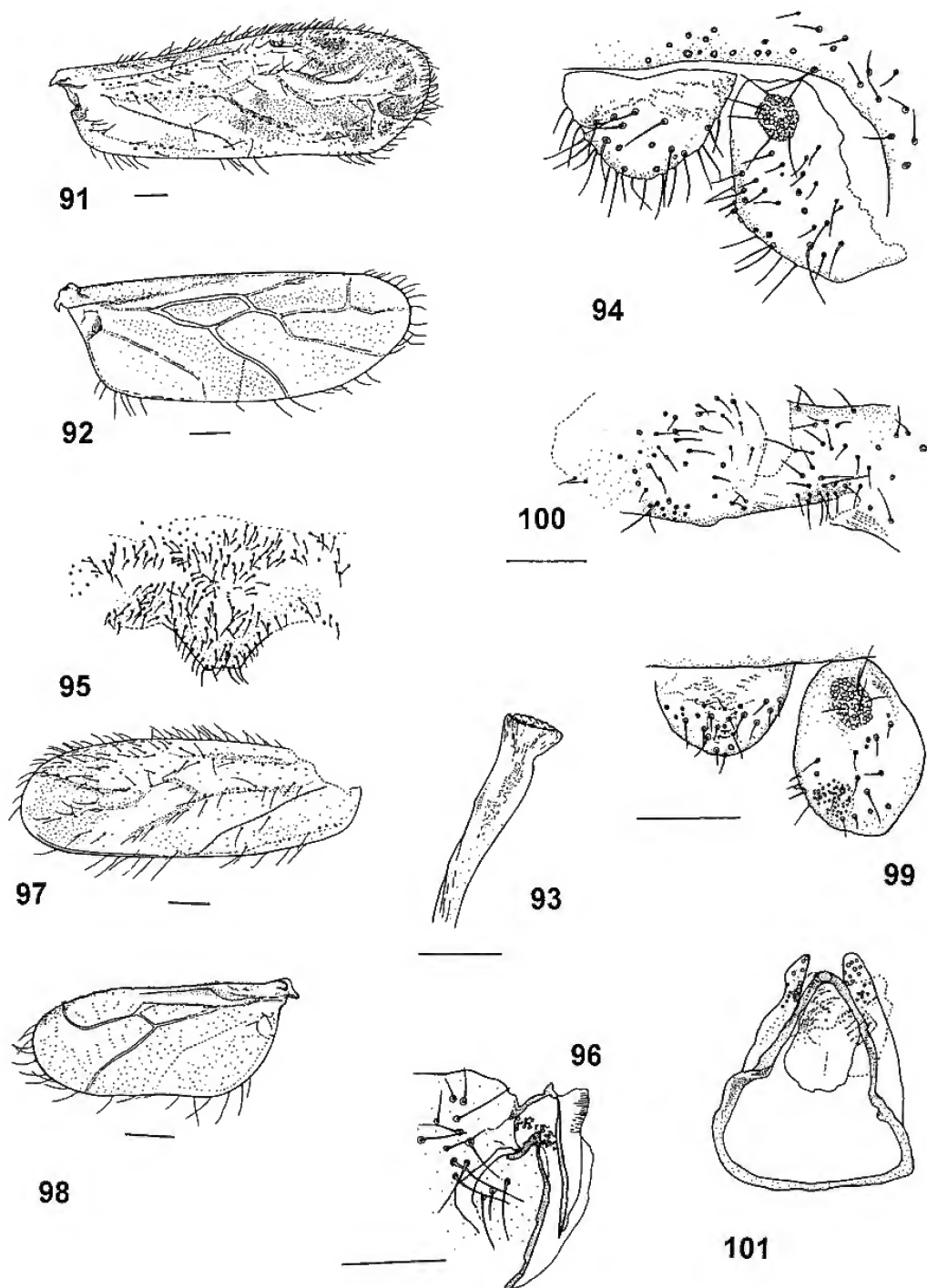
Description of female. *Coloration* (after ca 2 years in alcohol). Head very dark brown except for buff vertex. Scape, pedicel, f_1 and f_2 dark brown, f_3 – f_{11} slightly paler (from Hickman specimen). Maxillary palps brown, apical segment dark brown. Eyes black. Fore wing (fig. 91) and hind wing (fig. 92) with shades of brown. Thorax and legs dark brown, trochanter pale brown, tibiae merging brown apically. Abdomen pale mauve with darker annulations, terminal segments dark brown.

Morphology. IO:D = 3.4. Head and thorax glossy. Median epicranial suture distinct. Vertex rounded. Labrum: stylets large, spiculate; internal sclerotisation present; sensilla 5 in total. Lacinia (fig. 93, Hickman specimen) apically very broad, preapically expanded on one side, apical margin with broad denticles. Flagellar segments bearing long thick setae, f_1 slightly bent. Brachypterous. Fore wing (fig. 91) apical venation variable; setae on basal veins in at least 2 ranks; vein cu_2 strongly setose; setae long and standing relatively upright; veins rs and m fused for a short length. In hind wing (fig. 92) vein r sometimes simple. Microtrichia obvious in both wings. Mesothoracic precoxal suture absent. Abdominal adhesive vesicles absent. Epiproct (fig. 94). Paraproct (fig. 94) with round field of 10 trichobothria; small bifid projection and associated seta between one short and one long macroseta on posterior margin. Subgenital plate (fig. 95) with transverse apical margin, pigment band extending into two broad arms diverging anteriorly. Ventral valve of gonapophyses (fig. 96, Hickman specimen) considerably shorter than broad dorsal valve, external valve remnant bearing 2–3 setae. Spermatheca with long glandular area (sac not present).

Dimensions. B 2.3, FW 1.07, HW 0.81, F 0.66, T 0.98, t_1 0.355, t_2 0.126, rt 2.8:1, ct 0.0, f_1 0.419, f_2 0.284.

Description of male. *Coloration* (after ca 2 years in alcohol). As female, except vertex with dark brown pigment each side of median epicranial suture separating both pale regions laterally on vertex. Fore wing (fig. 97) and hind wing (fig. 98) generally as female.

Morphology. IO:D = 3.2. Head glossy, vertex rounded. Labrum and lacinia as female. Brachypterous. Venation of fore wing (fig. 97) reduced. Epiproct (fig. 99) with longitudinal raised area bearing a few papillae. Paraproct (fig. 99) with



Figures 91-101. *Nothocaecilius thomasi*. Female: 91, fore wing; 92, hind wing; 93, lacinia; 94, epiproct and paraproct; 95, subgenital plate; 96, gonapophyses. Figures 91, 95 and 93 and 94 to common scales. Male: 97, fore wing; 98, hind wing; 99, epiproct and paraproct; 100, hypandrium; 101, phallosome. Figures 99 and 101 to common scale.

round field of about 10 trichobothria; posterior margin with small bifid projection (side on for paraproct shown, appearing as a single cone) and associated seta between 2 small setae, an adjacent region of papillae. Hypandrium (fig. 100) with field of posterolateral setae on each side, median margin lacking setae. Phallosome (fig. 101) with transverse anterior margin.

Dimensions. B 2.0, FW 0.81, HW 0.46, F 0.56, T 0.84, t_1 0.308, t_2 0.111, rt 2.8:1, ct 0.0, f_1 0.466, f_2 0.308.

Remarks. This rare species, restricted to cool-temperate closed forest, was not collected during this study. It has also been found on *Nothofagus* by S. Thomas in Cape Otway National Park, Victoria. Males with micropterous wings have been collected.

Etymology. Named for Simon R. Thomas, in recognition of his contribution to the knowledge of Bass Strait Psocoptera.

Tasmanocaecilius gen. nov.

Diagnosis. With the characters of the tribe Epicaeciliini (Mockford, 2000) plus the following: clypeal shelf narrow; labral stylets present; abdominal adhesive vesicles absent; radial and medial veins in fore wing simple; radial vein in hind wing simple; stigmasac in fore wing absent; anterior margin of phallosome straight, transverse.

Type species: *Tasmanocaecilius truchanasi* sp. nov.

Remarks. This genus differs from other genera within the tribe by the venation and ciliation of the wings. The fore wing venation is only approached by *Ysiloneura* Pearman, but differs from that genus in possessing a simple medial vein, and lacking both a stigmasac and a spur-vein from the pterostigma.

Etymology. The generic name is a combination of the name Tasmania, the state, and *Caecilius*, a genus of Caeciliusidae.

Tasmanocaecilius truchanasi sp. nov.

Figures 102–07

Material examined. Holotype ♂: Tasmania, Cradle Mtn, Cradle Valley above Weindorfers grave, 41°38'S 145°57'E, fogging *Nothofagus cunninghamii*, 25 Feb 1990 (R. Coy, P. Lillywhite, A. Yen). Additional record (1♂, badly damaged): same data as holotype (MV).

Description of male. *Coloration* (after ca 2.5 years in alcohol). Body very dark brown. Eyes and median epistomal suture black. Fore wing (fig. 102) hyaline with brown markings. Hind wing (fig. 103) brown. Abdomen greyish-brown, terminal segments brown. Legs: coxae, femora and claws dark brown, trochanter pale, tibiae and tarsi brown.

Morphology. IO:D = 3.0. Head and thorax very glossy. Vertex rounded. Basal flagellar segment not enlarged, bent. Labrum: stylets small, spiculate; sensilla 5 in total; internal sclerotisation present. Lacinia (fig. 104) broad, expanded preapically on one side, apical margin denticulate; projection on median apical margin; bent midway. Maxillary palps and antennal flagellar segments beyond f_1 missing. Mesothoracic precoxal suture absent. Fore wing (fig. 102); radial and medial

veins simple; setae in a single rank; vein cu_2 glabrous; stigmasac absent. Hind wing (fig. 103) with radial vein simple. Microtrichia obvious on the membrane of both wings. Abdominal adhesive vesicles apparently absent. Epiproct (fig. 105). Paraproct (fig. 105) with small field of papillae and oval field of 15 trichobothria. Hypandrium (fig. 106) well sclerotised, posterolateral margins setose. Phallosome (fig. 107) aedeagus blunt tipped, anterior margin transverse and endophallus basally spiculate.

Dimensions. B 1.9, FW 2.30, HW 1.77, F 0.62, T 0.94, t_1 0.316, t_2 0.126, rt 2.5:1, ct 0.0, f_1 0.553.

Female. Unknown.

Remarks. The general area where this unusual species was found was well sampled. However, it was not collected in this study.

Etymology. Named for the late Olegas Truchanas, conservationist and nature photographer.

Lachesillidae

Lachesilla Westwood

Lachesilla Westwood, 1840: 47. Type species: *Hemerobius pedicularius* Linnaeus.

Lachesilla pedicularia (Linnaeus)

Hemerobius pedicularius Linnaeus, 1758: 551.

Lachesilla pedicularia. --- Enderlein, 1919: 16.

For complete synonymy see Lienhard and Smithers (2002).

Material examined. Risdon, 2♀, 1♂, 27 Apr 1938 (V. V. Hickman).

Distribution. Cosmopolitan.

Remarks. Previously recorded in Australia from Victoria and South Australia, this species was not collected during this survey.

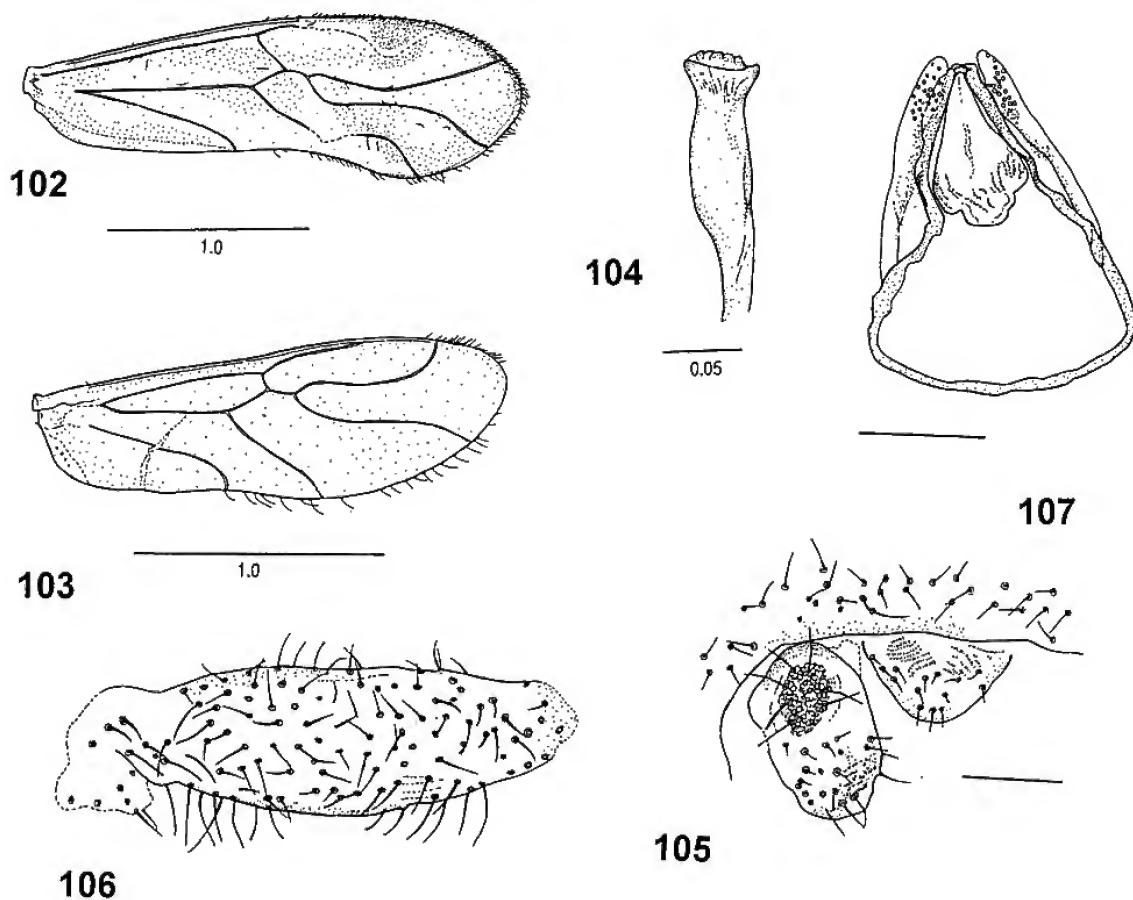
Ectopsocidae

Ectopsocus McLachlan

Ectopsocus McLachlan, 1899: 277. Type species: *Ectopsocus briggsi* McLachlan.

Key to Tasmanian species of *Ectopsocus**

1. Ground colour of head pale with obvious brown markings, fore wing with spots at end of veins 2
- Colour of head brown, fore wing lacking spots at end of veins 7
2. Posterior margin of paraproct with single spine *californicus* (Banks)
- Posterior margin of paraproct with pair of spines 3
3. Paraproct spines equal in size 4
- Paraproct spines not equal in size 5



Figures 102-107. *Tasmanocaecilius truchanasi*. Male: 102, fore wing; 103, hind wing; 104, lacinia; 105, epiproct and paraproct; 106, hypandrium; 107, phallosome. Figures 105 and 106 to common scale.

- | | | |
|---|-------------------------------------|---|
| 4. Single comb on ninth tergite of male, lobes of female subgenital plate long and slender | <i>briggsi</i> McLachlan | <i>coyae</i> sp. nov. |
| – Pair of combs on ninth tergite of male, lobes of female subgenital plate short and wide | <i>risdonensis</i> sp. nov. | – Rudimentary fore wing lacking convex dome in apical half |
| 5. Ninth sternite of male lacking field of ornamentation, gonapophyses lacking spermathecal sac | <i>rileyae</i> Schmidt and Thornton | 8 |
| – Ninth sternite of male with field of ornamentation, gonapophyses with spermathecal sac | 6 | 8. Phallosome with complex of asymmetrical sclerites, gonapophyses lacking ventral valve |
| 6. Endophallus with series of long spines, ventral valve of gonapophyses short and broad | <i>hickmani</i> sp. nov. | <i>vachoni</i> Badonnel |
| – Endophallus lacking spines, ventral valve of gonapophyses long and slender | <i>petersi</i> Smithers | – Phallosome without complex of asymmetrical sclerites, gonapophyses complete |
| 7. Rudimentary fore wing with convex dome in apical half ... | | 9 |
| | | 9. Male antenna with spines on two basal flagellar segments, endophallus with long sinuous sclerite, subgenital plate strongly spiculate between apical lobes |
| | | <i>graminus</i> sp. nov. |
| | | – Male antenna lacking spines on basal flagellar segments, endophallus lacking long sinuous sclerite, subgenital plate not spiculate between apical lobes |
| | | 10 |

10. Posterior margin of paraproct with single spine, macropterous forms with hind wing veins *r* and *m* joined by cross-vein *edwardsi* New
- Posterior margin of paraproct with pair of spines, macropterous forms with hind wing veins *r* and *m* fused ..
..... 11
11. Paraproct spines equal in size, tubercles present on male eighth tergite, inner parameres of phallosome fused apically, external valve of gonapophyses strongly spiculate, posterior margin of median area between apical lobes of subgenital plate adjacent to row of preapical setae
..... *axillaris* (Smithers)
- Paraproct spines unequal in size, tubercles absent on male eighth tergite, inner parameres of phallosome not fused apically, external valve of gonapophyses not spiculate, posterior margin of median area between apical lobes of subgenital plate and row of preapical setae separate 12
12. Endophallus lacking median sclerite, subgenital plate lobes angular with seven apical setae, lateral margins strongly sclerotised *brunneus* (Edwards)
- Endophallus with median sclerite, subgenital plate lobes rounded and shallow with four apical setae, lateral margins not sclerotised *sprenti* sp. nov.

* *Ectopsocus nerens* (Hickman) is not included in this key as genitalic information is not available.

Ectopsocus axillaris (Smithers)

Interpsocus axillaris Smithers, 1969: 293.

Ectopsocus axillaris. --- Thornton and Wong, 1968: 3.

Ectopsocus brunneus (Edwards). Cole et al., 1989: 33 (in part).

Material examined. **Site** 66, 6♀, 3♂, 4 Sep 86; 38♀, 4♂, 2 nymphs, 30 Oct 86; **site** 67B, 1♀, 19 Feb 88; **site** 85, 4♀, 11 Sep 86; 1♀, 10 Oct 86; **site** 92, 2♀, 11 Sep 86; **site** 94, 1♀, 6 Nov 86; **site** 142C, 12♀, 2♂, 24 Feb 88; **site** 181, 1, 13 Nov 86; **site** 269, 6♀, 3♂, 1 Mar 88; **site** 278A, 7♀, 25 Mar 87; **site** 352, 3♀, 21 Mar 88; **site** 357, 1♀, 7♂, 18 Mar 88; **site** 361, 5♀, 3♂, 25 Mar 88; **site** 363, 1♀, 27 Mar 88; **site** 366E, 4♀, 2♂, 16 Feb 88; **site** 366F, 3♀, 4♂, 16 Feb 88.

Distribution. Tasmania, King I (Bass Strait), Victoria, New Zealand, Ireland and Britain.

Remarks. *E. axillaris* appears to have little habitat specificity, being found on dead foliage from rainforest, mixed forest, dry and wet forests. Smithers and O'Connor (1991) have noted the unusual distribution of this species with its discovery in Ireland. The records of Cole et al. (1989) of *Ectopsocus brunneus* (Edwards) from King I are incorrect. Subsequent examination of these specimens indicates that they are conspecific with Victorian and Tasmanian material of this species.

The incidence of *E. axillaris* (and the closely related *E. brunneus*) suggests that they are spring and autumn species with summer and winter breaks. Few individuals were found, and the suggested phenology would need to be substantiated with additional sampling.

Ectopsocus briggsi McLachlan

Ectopsocus briggsi McLachlan, 1899: 277

Material examined. Many individuals collected throughout the year.

Distribution. Cosmopolitan.

Remarks. *E. briggsi* and *E. californicus* were taken at many sites. In dry vegetation they were common on broad-leaved foliage (e.g. *Acacia melanoxylon* and *Myoporum insulare*), and were numerous on dead *Eucalyptus* foliage from both dry and wet forests.

Ectopsocus brunneus (Edwards)

Interpsocus brunneus Edwards, 1950: 126

Ectopsocus brunneus. --- Thornton and Wong, 1968: 3.

Ectopsocus brunneus. --- Cole et al., 1989: 33 (in part).

Material examined. **Site** 2, 1♀, 29 Mar 88; **site** 168, 1♀, 25 Apr 87; **site** 181, 1♂, 14 Oct 86; 1♀, 26 Apr 87; **site** 200C, 1♂, 18 Apr 87; **site** 231, 1♀, 16 Nov 86.

Distribution. Tasmania, Flinders I (Bass Strait) and New South Wales.

Remarks. See those for *E. axillaris*. Few individuals were found, but the wide range of vegetation from which they were taken indicates little habitat specificity.

Ectopsocus californicus (Banks)

Peripsocus californicus Banks, 1903: 237.

Ectopsocus californicus. --- Peck, 1951: 413.

Ectopsocus froggatti Enderlein, 1906: 407.

Ectopsocus sp. H. Cole et al., 1989: 33.

Ectopsocus sp. M. Cole et al., 1989: 33.

Material examined. Many individuals collected throughout the year.

Distribution. Cosmopolitan.

Remarks. See those for *E. briggsi*.

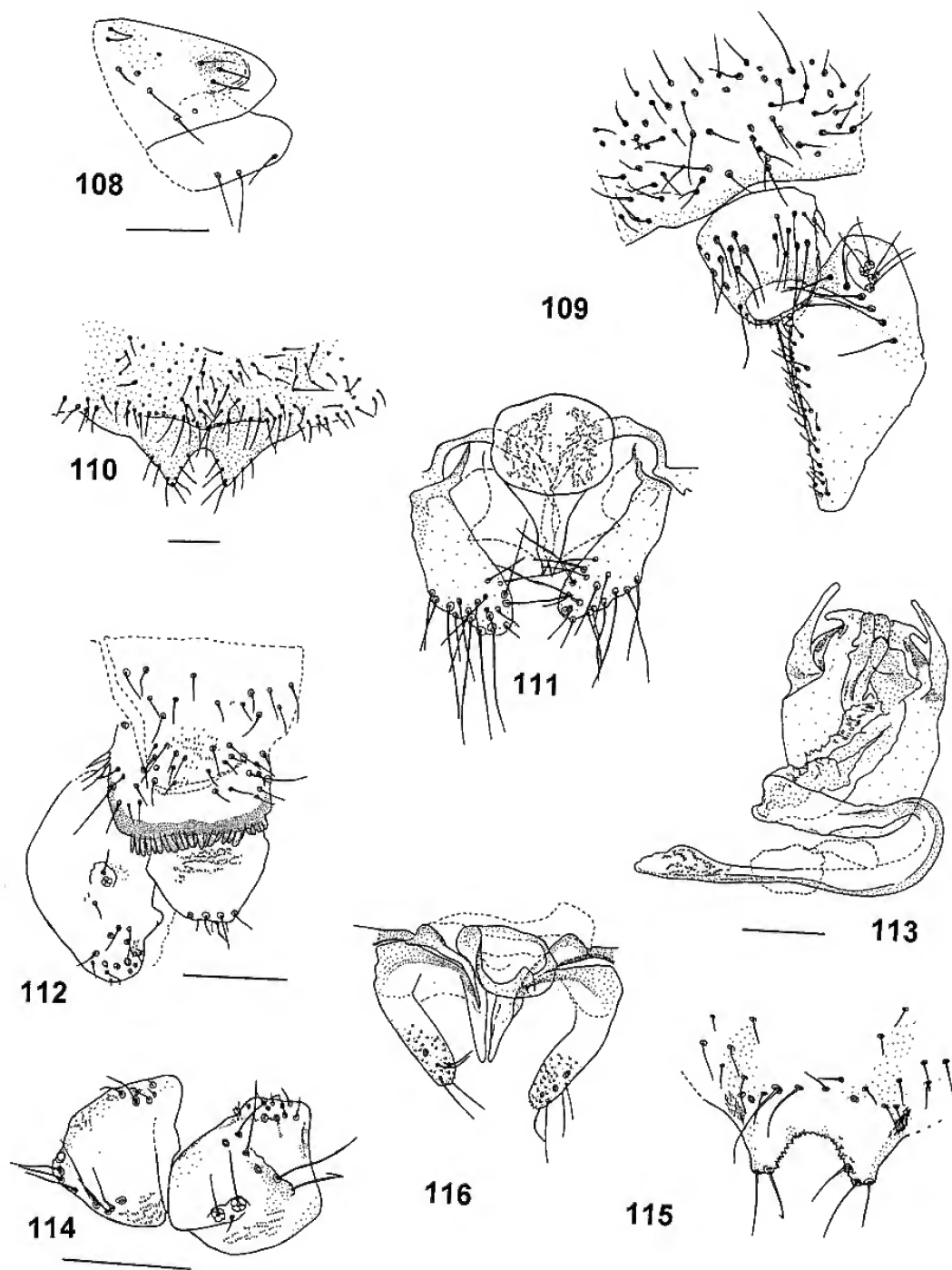
Ectopsocus coyae sp. nov.

Figures 108–11

Material examined. Holotype ♀: Tasmania, Rocky Cape National Park, Sisters Beach Road, wet scrub, 25 Oct 1986.

Description of female. **Coloration** (after ca 7 years in alcohol). Head brown with the following dark brown: markings dorsal to eyes, along back of vertex and on each side of black median epicranial suture; broad patch on frons, between ocelli and dark epistomal suture; postclypeal striae and labrum. Eyes black. Anteclypeus colourless. Fore wing (fig. 108), hind wing (fig. 108), thorax and legs brown, thoracic sutures dark brown. Abdomen buff, terminal segments brown.

Morphology. IO:D = 3.5. Median epicranial suture not distinct on anterior half of vertex. Ocelli absent. Distal margin of labrum with 5 sensilla. Distinct row of 6 trichoid sensilla on anterior margin of outer surface of labrum, each lateral sensillum much smaller than the four median sensilla. Epistomal suture present, clypeal shelf absent. Lacinia apically bifid, apex of outer projection bidentate. Vertex with vague suggestion of being



Figures 108-116. (108-111) *Ectopsocus coxae*. Female: 108, fore wing and hind wing; 109, epiproct and paraproct; 110, subgenital plate; 111, gonapophyses. Figures 108, 109 and 111 to common scale. (112-116) *Ectopsocus graminus*. Male: 112, epiproct, paraproct and ninth tergite; 113, phallosome. Female: 114, epiproct and paraproct; 115, subgenital plate; 116, gonapophyses. Figures 112, 115 and 116 to common scale.

sculptured with large polygonal-shaped cells. Flagellar segments with two placoids near base of f_1 , one at apices of f_4 , f_6 and f_{10} ; placoids of f_6 and f_{10} with a long slender filament. Fore wing and hind wing (fig. 108) as small setose rudimentary flaps, a small spiculate dome located on apical half of fore wing and a few setae on posterior margin of hind wing. Epiproct (fig. 109): basally sclerotised, bearing setae each side of median line; posterior margin bearing 2 large setae (one missing in preparation) and a row of minute setae. Paraproct (fig. 109) with 3–4 trichobothria and 1 seta not in rosette. Posterior margin bearing group of setae and a single spine, median region bearing a row of long setae. Subgenital plate (fig. 110): pair of apical sclerotised lobes, each bearing 7 setae; small median region between lobes not sclerotised; well developed row of preapical setae; pigment band not divided into anteriorly diverging arms. Gonapophyses (fig. 111): external valve well sclerotised, setose over apical third; dorsal valve broad, membranous, with spiculate apex; ventral valve sclerotised, apex spiculate. Spermathecal plate (fig. 111) membranous, rounded, containing numerous granules.

Dimensions. B 1.05, FW 0.20, HW 0.09, F 0.39, T 0.54, t_1 0.134, t_2 0.095, rt 1.4: 1, ct 0.0, f_1 0.150, f_2 0.087.

Male. Unknown.

Remarks. This species is similar to *Ectopsocus edwardsi* (below) in details of coloration and genitalia. The lobes of the subgenital plate are somewhat angular, and the apices bluntly pointed compared to the shallow rounded lobes of *E. edwardsi*. The setae are more numerous on the external valve of the gonapophyses of *E. coyae*. The wings of the two species differ considerably. The small spiculate dome on the fore wing and the setae on the hind wing (fig. 108) are absent in *E. edwardsi*.

Etymology. Named for Dr Robyn Coy, in recognition of her contribution to the knowledge of Tasmanian rainforest invertebrates.

Ectopsocus edwardsi New

Ectopsocus edwardsi New, 1973b: 347.

Material examined. Site 248A, 2♀, 14 June 86; 3♀, 1 nymph, 24 Aug 86; 1♀, 23 Sep 86.

Distribution. Tasmania, Victoria and New South Wales.

Remarks. The few specimens collected during this study were all taken at Sisters Beach from *Banksia serrata*.

Ectopsocus graminus sp. nov.

Figures 112–16

Material examined. Holotype ♂: Tasmania, Jackeys Marsh (east), *Carex appressa*, 12 Nov 1986. Four ♂ and 4♀ paratypes: same data as holotype. Additional record: 1♀, South Arm Recreation Area, tussock grasses, 18 July 1986.

Description of male. **Coloration** (after ca 7 years in alcohol). Buff. Head with vague suggestions of darker markings dorsal to eyes, and on each side of pale median epicranial suture. Eyes black. Thoracic pleura brownish, markings extending from this posteriorly as brown flecks on lateral margins of abdominal terga.

Morphology. IO:D = 4.25. Ocelli absent. Distal margin of labrum with 5 sensilla. Distinct row of 6 trichoid sensilla, 4 median in line and each lateral slightly posteriorly on anterior margin of outer surface of labrum. Epistomal suture present, clypeal shelf absent. Lacinia apically bifid, lateral projection apically bidentate and larger than median projection. Two basal flagellar segments with strong spinous setae on outer margin, 5 on f_1 and 3 on f_2 . Distribution of placoids as follows: 1 third from base on f_1 , 1 at apices of f_1 , f_4 , f_6 and f_{10} ; those on f_6 and f_{10} possessing a long slender hyaline filament. Fore wings as small setose rudimentary flaps. Hind wings absent. Epiproct (fig. 112) bearing 3 small setae and 1 large seta apically, preapically a row of 4 large setae. Paraproct (fig. 112) with 1–2 trichobothria, posterior margin bearing a pair of spines and associated seta. Ninth tergite (fig. 112) with apical comb of long rounded teeth, setose. Apex of eighth tergite and lateral margins of ninth sternite lacking ornamentation. Hypandrium with transverse apical margin, setose. Phallosome (fig. 113) with unusual long sinuous sclerite.

Dimensions. B 1.7, FW 0.16, F 0.403, T 0.521, t_1 0.142, t_2 0.087, rt 1.6:1, ct 0.0, f_1 0.348, f_2 0.190.

Description of female. **Coloration** (after ca 7 years in alcohol). As male.

Morphology. IO:D = 4.0. Two basal flagellar segments with a single long seta at apex. Features of head and wings as male. Epiproct (fig. 114). Paraproct (fig. 114) with 1–2 trichobothria, posterior margin bearing pair of spines and associated seta. Subgenital plate (fig. 115) bearing 2–3 setae on each lobe, apical margin between lobes spiculate, preapical row of setae including a pair of large setae (one absent in preparation). Gonapophyses (fig. 116). Spermathecal plate (fig. 116) with circular sclerotisation.

Dimensions. B 1.8, FW 0.17, F 0.38, T 0.49, t_1 0.118, t_2 0.087, rt 1.4:1, ct 0.0, f_1 0.269, f_2 0.150.

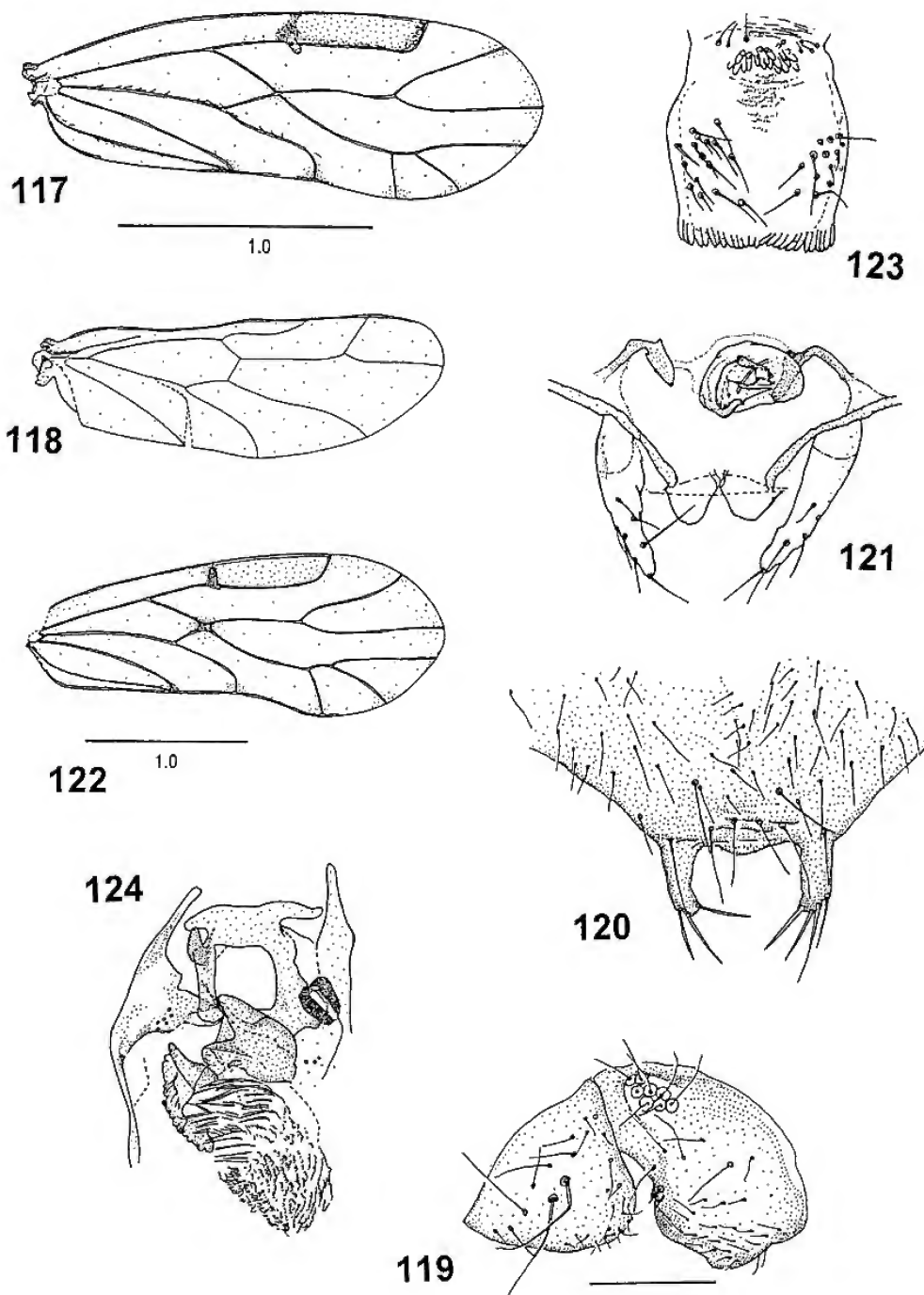
Remarks. By possessing a long sinuous sclerite the phallosome of this species resembles that of *Ectopsocus vilhenai* Badonnel, found in Africa, Madagascar, Central America and Venezuela. *E. vilhenai* differs in the following features from *E. graminus*: an elongated penial frame, the fused inner parameres with two lateral rounded lobes, the eighth tergite with characteristic ornamentation, and macroptery. Females of the two species also differ in details of genitalia, particularly in the shape of the subgenital plate apical lobes and in differences of the valves of the gonapophyses. Males possessing spinous setae on the two basal flagellar segments of the antenna were hitherto only known in *Mascaropsocus spinosus* Badonnel and Pearman (1971: 859, fig. 1), known only from the Mascarene Is.

Etymology. In reference to the low grassy habitat of this species.

Ectopsocus hickmani sp. nov.

Figures 117–24

Material examined. Holotype ♀: Tasmania, the Domain, Hobart, from loose bark on eucalypts, 17–18 Apr 1968. One ♀ and 4♂ paratypes: same data as holotype (V.V. Hickman).



Figures 117-124. *Ectopsocus hickmani*. Female: 117, fore wing; 118, hind wing; 119, epiproct and paraproct; 120, subgenital plate; 121, gonapophyses. Male: 122, fore wing; 123, ninth tergite; 124, phallosome. Figures 117, 118 and 119-121, 123 and 124 to common scales.

Description of female. Coloration (after ca 25 years in alcohol). Head buff with the following brown: confluent markings dorsal to eyes, along back of vertex and each side of median epicranial suture; region between ocelli; broad band on frons adjacent to epistomal suture; postclypeus, except area near each ventrolateral margin; labrum; band between eye and antenna socket; antenna. Eyes black. Fore wing (fig. 117) hyaline, with ten brown clouds: one at apex of each vein at wing margin, one at the apex and base of the pterostigma and one at the *rs* – *m* junction. Hind wing (fig. 118) hyaline. Thorax brown, sutural areas darker. Legs buff. Abdomen buff, lateral margins of terga with incipient annulations, terminal segments pale.

Morphology. IO:D = 4.0. Median epicranial suture not distinct. Distal margin of labrum with 5 sensilla. Distinct row of six trichoid sensilla on anterior margin of outer surface of labrum, four median in a row and each lateral sensillum posteriorly to these. Epistomal suture present, clypeal shelf absent. Lacinia apex not divided, outer margin longer than median. Flagellar segments bearing setae of differing lengths, larger setae on (anterior) outer margin. Placoid sensilla distributed as follows: 2 base *f*₁, 1 apices *f*₄, *f*₆ and *f*₁₀; sensilla of *f*₆ and *f*₁₀ possessing a long slender filament. Apex of terminal segment narrowed, bluntly rounded. Fore wing (fig. 117) with veins bearing single row of short, distally slanting setae; vein *cu*₂ glabrous; stigmasac prominent. Hind wing (fig. 118) with veins *r* and *m+cu* fused for short distance at base of wing; veins *r* and *m* joined by a small cross-vein, about six small setae on margin between radial fork. Epiproct (fig. 119) setose, pair of prominent setae on central unsclerotised region. Paraproct (fig. 119) with round field of 8–9 trichobothria, posterior margin bearing pair of adjacent unequal duplex spines and associated seta. Subgenital plate (fig. 120): prominent apical lobes each bearing 3–4 strong apical setae; preapical row of setae divided into 4 median and 2 lateral, latter setae near the lateral margin of plate; pair of large setae medially on plate; apex of median region between lobes spiculate. Gonapophyses (fig. 121): ventral valve short, sclerotised, with spiculate apex; dorsal valve short, apically broadly rounded, spiculate; apical half of external valve bearing about 6 scattered shorter setae and 1 large seta, apex also spiculate. Spermathecal sac (fig. 121) small, sclerotised.

Dimensions. B 2.0, FW 1.98, HW 1.50, F 0.45, T 0.73, *t*₁ 0.253, *t*₂ 0.095, *rt* 2.7:1, *ct* 14.0, *f*₁ 0.379, *f*₂ 0.213.

Description of male. Coloration (after ca 25 years in alcohol). As female. Fore wing as in fig. 122.

Morphology. IO:D = 3.0. Features of head and wings as female. Epiproct with apical third setose. Paraproct with round field of trichobothria and duplex spines as in female. Ninth tergite (fig. 123, paratype) with apical comb of rounded teeth, shorter over central section. Apex of eighth tergite with semicircular field of blunt spines (fig. 123, paratype). An ill-defined field of short spines on ninth sternite lateral to the field on eighth tergite. Hypandrium apical margin transverse, a pair of long setae on each lateral margin adjacent to a small sclerotised thickening. Phallosome (fig. 124) similar to that of *Ectopsocus petersi*, with a single “thimble” structure near apex of inner fused parameres. Endophallus with well developed spiculate lobe and a series of long spines.

Dimensions. B 2.0, FW 2.45, HW 1.80, F 0.50, T 0.90, *t*₁ 0.276, *t*₂ 0.095, *rt* 2.9:1, *ct* 17.0, *f*₁ 0.498, *f*₂ 0.308.

Remarks. Of the genitalic features listed by Schmidt and Thornton (1993: 165, Table 3) for seven species of *Ectopsocus* this species is most similar to those of *Ectopsocus australis*, now a synonym of *E. petersi* (Smithers, 2003). Both species share the following: straight apical lobes of the subgenital plate, adjacent unequal duplex spines on the posterior margin of the paraproct, the presence of a spermathecal sac, a single “thimble” structure on the phallosome and a field of spines on the apex of the eighth tergite. *Ectopsocus hickmani* differs from *E. petersi* on two features of the subgenital plate: apical lobes are not separated from the disc by a suture, and the projection between the distal setae of the apical lobe is absent. The long spines associated with the endophallus of *E. hickmani* are absent in *E. petersi*.

Etymology. Named for the late Prof. Vernon V. Hickman, who collected the specimens of this species.

***Ectopsocus nerens* (Hickman)**

Microsocus nerens Hickman, 1934: 88.

Ectopsocus nerens. --- Roesler, 1944: 154.

Remarks. No material was collected in this study which could be assigned to this species. Material consists of the holotype (female) only, which has a fore wing 1.16 mm long with incipient spots at the ends of the veins. Unusually, vein *cu*₂ of the fore wing is setose (Hickman, 1934: fig. 6a). For the duration of this study the type specimen was unavailable.

***Ectopsocus petersi* Smithers**

Ectopsocus petersi Smithers, 1978: 144.

Ectopsocus australis Schmidt and Thornton, 1993: 162.

Ectopsocus sp. E. Cole et al., 1989: 33.

Ectopsocus froggatti Enderlein. Coy et al., 1993: 77.

Material examined. Many individuals collected throughout the year.

Distribution. Cosmopolitan.

Remarks. *E. petersi* was collected from living foliage, predominantly in wet and mixed forests, and rainforest. Considerable colour variation has been found in this species, from that of the original description (and also the description of *E. australis*) to specimens that are extremely pale, lacking any brown body coloration and spots on the wings. ERS has examined material of *Ectopsocus* sp. E of Cole et al. (1989), and they are clearly of this species.

***Ectopsocus rileyae* Schmidt and Thornton**

Ectopsocus rileyae Schmidt and Thornton, 1993: 167.

Material examined. **Site** 19A, 1♀, 31 Mar 87; **site** 53, 1♀, 7 June 87; **site** 74, 1♂, 18 Mar 87; **site** 115B, 2♂, 22 Feb 88; **site** 118, 1♀, 9 Nov 86; **site** 119A, 6♀, 10 Nov 86; **site** 119B, 2♀, 3♂, 22 Feb 88; **site** 119C, 3♀, 2♂, 22 Feb 88; **site** 219D, 5♂, 19 May 87; **site** 220, 2♂, 27 Nov 86; **site** 224B, 1♀, 27 Feb 88; **site** 230B, 1♂ 15 Sep 86; **site** 248A, 1♂, 14 June 86; **site** 280A, 1♂, 14 June 86; **site** 313, 1♀, 30 Nov 86; **site** 361, 1♂, 25 Mar 88.

Distribution. Tasmania and Victoria.

Remarks. This species was mainly found in rainforest, mixed forest and wet forest.

Ectopsocus risdonensis sp. nov.

Figures 125–32

Material examined. Holotype ♀: Tasmania, East Risdon, from shrubs, 27 Apr 1961. Thirteen ♀ and 6 ♂ paratypes: same data as holotype (V.V. Hickman).

Description of female. *Coloration* (after ca 32 years in alcohol). Ground colour of head buff, with the following dark brown: patches (some confluent) dorsal to eyes, across back of vertex and on each side of median epicranial suture; round mark on frons between median ocellus and epistomal suture; prominent striae on postclypeus converging towards midline. Apical segment of maxillary palpi brown. Eyes black. Ocelli pale, with brown centripetal margins. Fore wing with strong clouds at the end of veins and at *rs* and *m* junction, brownish tinge on membrane (fig. 125). Hind wing hyaline (fig. 126). Thorax brown, pleural sutures dark brown. Thoracic dorsa dark brown, paler along sutures. Legs pale brown. Abdomen buff.

Morphology. IO:D = 4.5. Epistomal suture with median region convex, clypeal shelf absent. Distal margin of labrum with 5 sensilla. Distinct row of 7 trichoid sensilla on anterior margin of outer surface of labrum. Lacinia apically bifid, outer projection larger than median. Head densely covered by setae of various lengths. Anterior margin of postclypeus bearing a row of 6 strong setae, divided medially into 2 groups of 3 setae. Antenna short, setae on flagellar segments differing in length. Placoid sensilla distributed as follows: 2 at base f_1 , 1 apices f_4 , f_6 and f_{10} ; placoids on f_6 and f_{10} bearing a long slender filament. Apex of terminal segment narrowed, bluntly rounded. Fore wing veins bearing a row of distally slanting setae (fig. 125), vein cu_2 glabrous. Hind wing (fig. 126): veins *r* and *m* joined by a cross-vein; veins *r* and *m+cu* fused for short distance basally; setae on margin absent. Epiproct (fig. 127) bearing 2 prominent apical setae. Paraproct (fig. 127) with 7/8 trichobothria and a median row of strong setae, posterior margin with 2 small cones and associated seta (not apparent on paraproct figured). Subgenital plate as in fig. 128. Gonapophyses and spermathecal plate (fig. 129).

Dimensions. B 1.35, FW 1.27, HW 1.03, F 0.28, T 0.47, t_1 0.166, t_2 0.087, rt 1.9:1, ct 9.0, f_1 0.182, f_2 0.095.

Description of male. *Coloration* (after ca 32 years in alcohol). As female. Fore wing pigmented as in fig. 130.

Morphology. IO:D = 3.3. General morphology similar to female, except anterior margin of outer surface of labrum bearing distinct row of 6 trichoid sensilla, flagellar segments of antennae much thicker than those of female. Epiproct (fig. 131). Paraproct (fig. 131) with 8 trichobothria, duplex spines and associated seta as on female. Ninth tergite (fig. 131) with two apical combs of long rounded teeth: apical row slightly sinuous, teeth shorter medially than laterally; basal comb straight, teeth shortest laterally; lateral margins bearing prominent rugose areas. Apex of eighth tergite ovoid, bearing scattered tubercles. Ninth sternite lacking ill-defined fields of ornamentation. Hypandrium with lateral apical margins

bearing long setae, median margin lightly sclerotised. Phallosome (fig. 132) with a pair of apical outcurving spines, adjacent to a long sclerotised spine.

Dimensions. B 1.3, FW 1.56, HW 1.24, F 0.28, T 0.50, t_1 0.166, t_2 0.087, rt 1.9:1, ct 8.0, f_1 0.241, f_2 0.134.

Remarks. This species appears most closely related to *Ectopsocus cetratus* Smithers, from Western Australia and South Australia. Males of both species possess a pair of apical combs on the ninth tergite, a characteristic feature of *Ectopsocopsis* Badonnel, and the female subgenital plate is identical in these species. This species differs from *Ectopsocus cetratus* in four ways: a narrow ventral valve of the gonapophyses, the ornamentation of the apex of the eighth tergite, the characteristic sclerites of the endophallus, and fore wing pigmentation. *Ectopsocus cetratus* is also a larger species (body length: ♀ 2.0 mm, ♂ 1.85; wing length: ♀ 2.0 mm, ♂ 1.9 mm) than *Ectopsocus risdonensis*. This species was not collected during the present study.

Etymology. The specific name refers to the type locality, East Risdon.

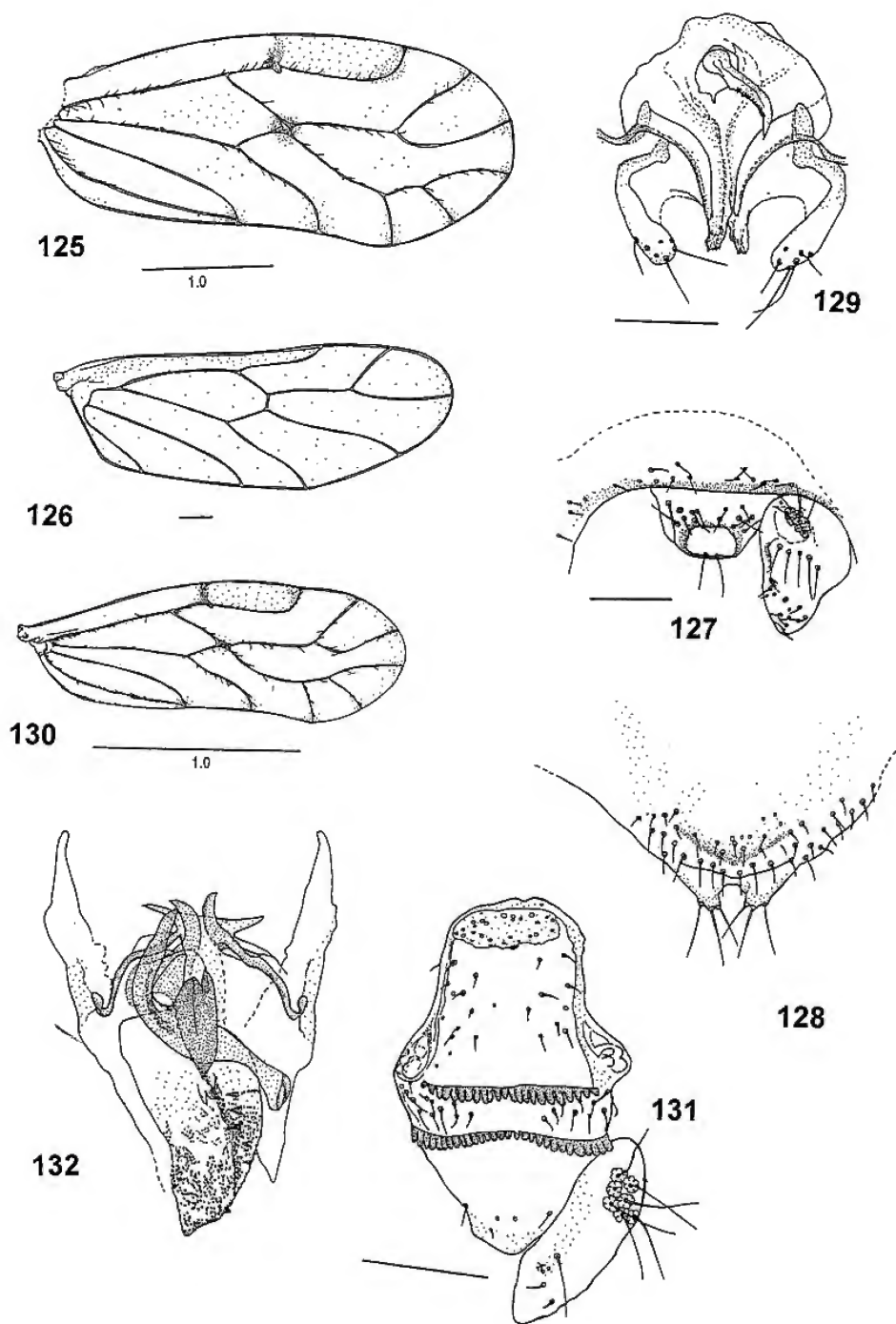
Ectopsocus sprengi sp. nov.

Figures 133–41

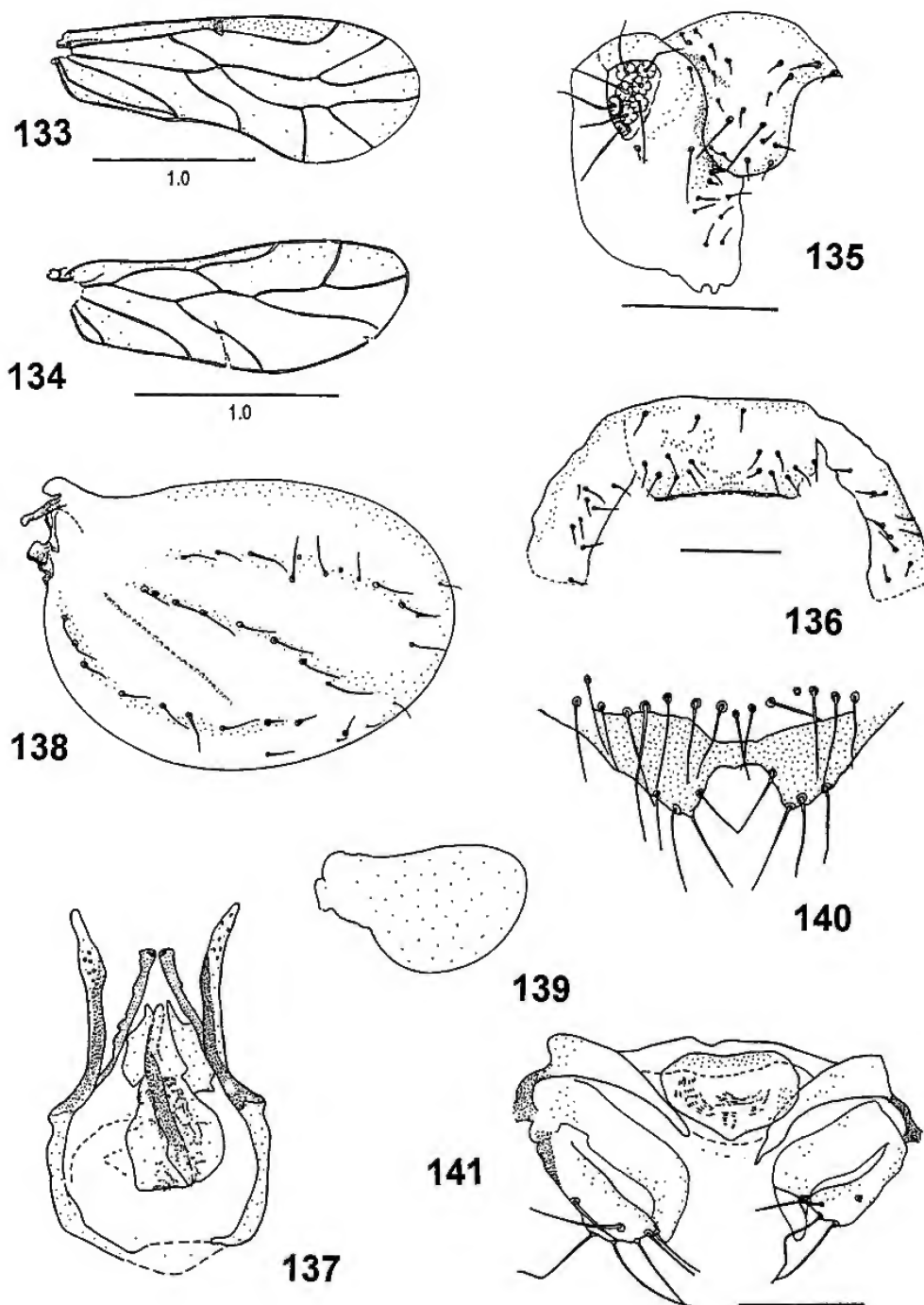
Material examined. Holotype ♂: Tasmania, South Arm Recreation Area, dead *Eucalyptus* foliage, 3 Sep 1986. Paratype ♀ and 1 nymph: same data as holotype.

Description of male. *Coloration* (after ca 7 years in alcohol). Head brown, with vague darker markings dorsal to eyes, each side of dark median epicranial suture and on postclypeus, striae converging towards midline. Ocelli dark brown, with dark brown centripetal margins. Antenna pale brown. Eyes black. Fore wing hyaline (fig. 133), veins brown. Hind wing hyaline (fig. 134). Thorax and legs brown. Abdomen cream.

Morphology. IO:D = 3.0. Epistomal suture present, clypeal shelf absent. Distal margin of labrum with 5 sensilla. Distinct row of 6 trichoid sensilla on anterior margin of outer surface of labrum, each lateral sensillum slightly apart from the 4 median. Lacinia apically bifid, lateral projection larger than median. Head covered by setae of various lengths. Setae on flagellar segments of uniform length. Distribution of placoids as follows: 2 at base f_1 , 1 at apices f_4 , f_6 and f_{10} ; those on f_6 and f_{10} bearing a long slender filament. Apex of terminal segment bluntly rounded. Fore wing (fig. 133): veins bearing single row of distally slanting setae; vein cu_2 glabrous; pterostigma elongated, posterior apex rounded, shape not rectanguloid as is usual for the genus. Hind wing (fig. 134) with veins *rs* and *m* fused for a length; veins *r* and *m+cu* fused for a length basally, setae on margin absent. Epiproct (fig. 135). Paraproct (fig. 135) with 8 trichobothria, posterior margin bearing a pair of unequal duplex spines and associated seta. Ninth tergite (fig. 136) bearing apical comb of very short blunt spines. Apex of eighth tergite and lateral margins of ninth sternite lacking fields of ornamentation. Hypandrium apical margin strongly setose. Phallosome (fig. 137) with inner parameres meeting apically, endophallus bearing strong median sclerite.



Figures 125-132. *Ectopsocus risdonensis*. Female: 125, fore wing; 126, hind wing; 127, epiproct and paraproct; 128, subgenital plate; 129, gonapophyses. Figures 127 and 128 to common scale. Male: 130, fore wing; 131, epiproct, paraproct and ninth tergite; 132, phallosome. Figures 131 and 132 to common scale.



Figures 133-141. *Ectopsocus sprengi*. Male: 133, fore wing; 134, hind wing; 135, epiproct and paraproct; 136, ninth tergite; 137, phallosome. Female: 138, fore wing; 139, hind wing; 140, subgenital plate; 141, gonapophyses. Figures 135 and 137-140 to common scale.

Dimensions. B 1.60, FW 2.12, HW 1.62, F 0.37, T 0.59, t_1 0.174, t_2 0.095, rt 1.8:1, ct 11.0, f_1 0.237, f_2 0.142.

Description of female. *Coloration* (after ca 7 years in alcohol). As male. Fore wing (fig. 138) and hind wing (fig. 139) hyaline.

Morphology. IO:D = 3.0. Ocelli present, very small. Epistomal suture present, clypeal shelf absent. Distal margin of labrum with 5 sensilla. Anterior margin of outer surface of labrum with distinct row of 6 trichoid sensilla. Flagellar segments with setae of differing lengths. Distribution of placoid sensilla as follows: 1 at two-thirds distance from base of f_1 (on other antenna 1 at apex f_1), 1 apices f_4 , f_6 and f_{10} , those of f_6 and f_{10} with a long slender filament. Micropterous. Fore wing (fig. 138) with venation reduced, setae in a single row on veins, vein cu_2 glabrous. Hind wing (fig. 139) reduced to small veinless flap. Epiproct setose, with 2 prominent apical setae. Paraproct with 2 trichobothria and one seta not in rosette, posterior margin with pair of small unequal duplex spines and associated seta. Subgenital plate (fig. 140) apical lobes with 4 setae. Gonapophyses (fig. 141) with ventral valve broad, dorsal valve with spiculate apex, greater in length than external valve, apically with about 6 setae. Spermathecal plate (fig. 141) rounded.

Dimensions. B 1.35, FW 0.24, HW 0.09, F 0.28, T 0.43, t_1 0.158, t_2 0.079, rt 2:1, ct 0.0, f_1 0.111, f_2 0.079.

Remarks. This species is similar to *E. brunneus* (both sexes macropterous) in general colour, in the fusion of veins *rs* and *m* in the hind wing and in the shape of the inner parameres of the phallosome. *E. sprengi* differs in possessing fewer setae on the male fore wing, the male hind wing lacking marginal setae, the endophallus containing a large median sclerite, and microptery in females. *E. sprengi* is a much smaller species than *E. brunneus*. The female of *E. sprengi* is similar to that of *E. edwardsi* in general morphology and in details of genitalia. The shape of the apical lobes of the subgenital plate, the form of the gonapophyses and shape of the spermathecal plate are similar in both species. *E. sprengi* differs from *E. edwardsi* in details of chaetotaxy on the apical lobes of the subgenital plate and on the external valve of the gonapophyses. The duplex spines of the paraproct also differ between the two species.

Etymology. Named for James Spreng, an early surveyor and explorer in Tasmania.

***Ectopsocus vachoni* Badonnel.**

Ectopsocus vachoni Badonnel, 1945: 44.

Material examined. University of Tasmania, Hobart, litter from wet gully, 6♀, 28 Apr 1984.

Distribution. Cosmopolitan.

Remarks. The present material includes only micropterous individuals with rudimentary wing buds, as figured by Badonnel (1945: 44, fig. 30). In Australia this species could be confused only with *Ectopsocus spiculatus* New, found in Victoria. New (1973b) noted the similarities and differences between the two species. This widespread species has previously been recorded from Western Australia (Smithers, 1996c).

***Ectopsocus* sp.**

Figures 142–46

Material examined. The (Queens) Domain, Hobart, from loose bark on eucalypts, 1♀, 17–18 Apr 1968 (V. V. Hickman).

Remarks. This single individual apparently represents a new species. However, while slide material is available, the rest of the insect, in alcohol, has been misplaced. The fore wing (fig. 142), hind wing (fig. 143), epiproct and paraproct (fig. 144), subgenital plate (fig. 145) and gonapophyses (fig. 146) with spermathecal sac are shown for future reference. Dimensions have also been included. The fore wing (fig. 142) has a brownish tinge on the membrane, and the hind leg is dark brown. The antennae are brown, the flagellar segments bearing setae of differing lengths. Placoid sensilla are distributed as follows: 2 in middle of f_1 , 1 at apices of f_4 , f_6 and f_{10} ; those on f_6 and f_{10} bearing a long slender filament. The apex of the terminal segment is narrowed and bluntly rounded. The posterior margin of the paraproct (fig. 144) bears a single spine, unlike the duplex unequal spines found in *E. hickmani* and *E. petersi*. The subgenital plate (fig. 145) apical lobes also differ from those of *E. hickmani* and *E. petersi*. The gonapophyses (fig. 146) bear a general resemblance to those of *E. petersi*. The spermathecal sac is similar in size to that of *E. hickmani*, which is smaller than that of *E. petersi*.

Dimensions. B 1.9, FW 1.50, HW 1.21, F 0.33, T 0.53, t_1 0.150, t_2 0.079, rt 1.9:1, ct 0.0, f_1 0.197, f_2 0.107.

Peripsocidae

Key to Tasmanian genera of Peripsocidae

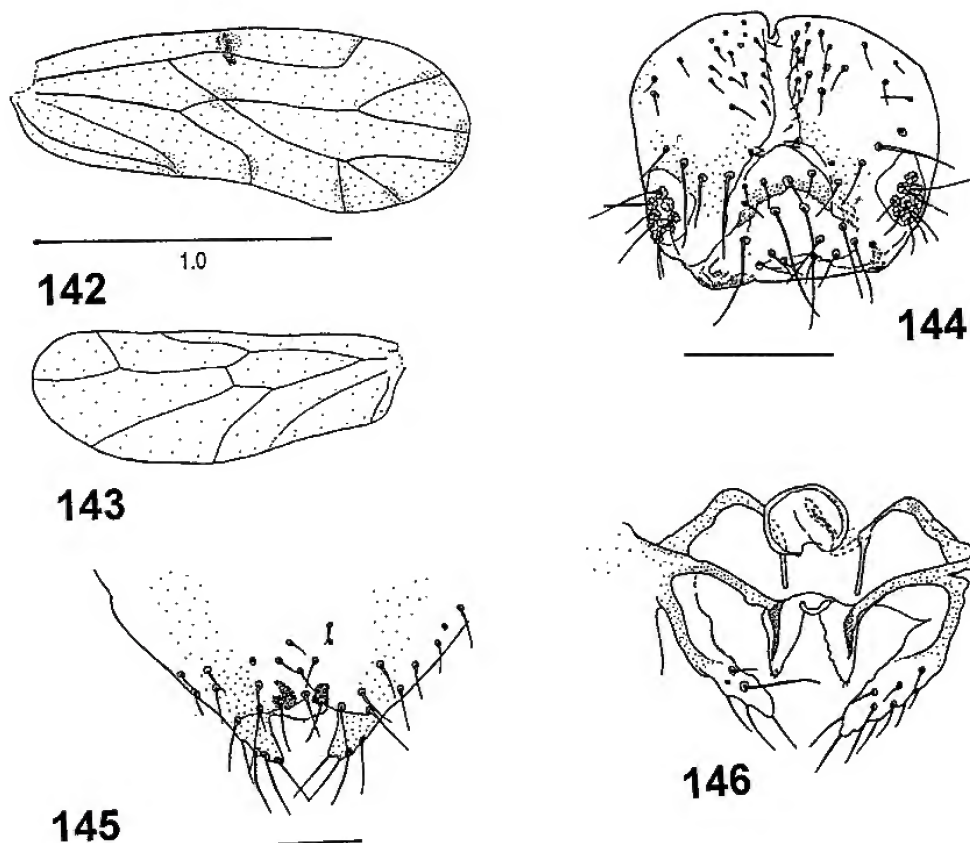
The two genera recorded from Tasmania are very similar, and females cannot be separated on genitalic features.

1. Wings broad, fore wing with distinct dark banding; phallosome basally broad, transverse, apex rounded and lacking acuminate point *Cycloperipsocus* Li Fasheng
- Wings not unduly broad, if marked – this as darker suffusion rather than discrete dark banding; phallosome tapered or rounded at base, apex usually tapered to slender median point *Peripsocus* Hagen

***Cycloperipsocus* Li Fasheng**

Cycloperipsocus Li Fasheng, 1993: 377. Type species: *Cycloperipsocus pangi* Li Fasheng.

Remarks. This genus was raised to contain a new Chinese species. The genus is very similar to more typical *Peripsocus*, and females may be differentiated only on the intensity of wing markings, as genitalia in the two genera are similar. Li Fasheng also included two Australian species in his initial concept of *Cycloperipsocus*. One of these occurs in Tasmania, as below, but its recognition is facilitated by including it in a broader key to *Peripsocus*, which we have opted to do, whilst not formally changing its current placement.



Figures 142-146. *Ectopsocus* sp. Female: 142, fore wing; 143, hind wing; 144, epiproct and paraprocts; 145, subgenital plate; 146, gonapophyses. Figures 142, 143 and 144 and 146 to common scales.

Cycloperipsocus edwardsi (New)

Peripsocus edwardsi New, 1973a: 340.

Cycloperipsocus edwardsi. --- Li Fasheng, 1993: 379.

Material examined. **Site** 27A, 1♀, 13 Feb 88; **site** 186, 1♀, 27 July 87; **site** 194A, 1♀, 27 July 87.

Distribution. Tasmania, Victoria, New South Wales and South Australia.

Peripsocus Hagen

Peripsocus Hagen, 1866b: 203. Type species: *Psocus phaeopterus* Stephens.

Key to Tasmanian species of *Peripsocus*

1. Macropterous 4
- Brachypterous or micropterous (♀ only) 2

2. Apex of dorsal valve of gonapophyses not spiculate *pamae* sp. nov.
- Apex of dorsal valve of gonapophyses strongly spiculate 3
3. Subgenital plate apex broad, transverse *mauricus* (Tillyard)
- Subgenital plate apex broad basally, tapered *edwardsi* New (*Cycloperipsocus*)
4. Fore wing with stem of rs as long as r_{4+5} ; subgenital plate lobe rectangular, longer than wide; small projection on posterior margin of male ninth tergite apically with sharp pointed teeth *milleri* (Tillyard)
- Fore wing with stem of rs shorter than r_{4+5} ; subgenital plate lobe squarish or apically tapered; posterior margin of male ninth tergite with large rounded clunium 5

5. Apex of dorsal valve of gonapophyses strongly spiculate; endophallus with large median conical sclerite and each side a large outwardly curving spine; arms of outer parameres sclerotised, projecting posterolaterally 6
- Apex of dorsal valve of gonapophyses not spiculate; endophallus with pair of symmetrical sclerites; arms of outer parameres membranous, projecting posteriorly 7
6. Subgenital plate apex broad, transverse; phallosome: apex of aedeagal arch tapered, with two lateral and one median rounded projections *maoricus* (Tillyard)
- Subgenital plate apex broad basally, tapered; phallosome: apex of aedeagal arch rounded, without projections *edwardsi* New (*Cycloperipsocus*)
7. Fore wing of male with thickened costa between wing base and base of pterostigma; endophallus with anterior spinous sclerites and posterior rounded sclerites; femora of legs lacking dark brown band 8
- Fore wing of male lacking thickened costa between wing base and base of pterostigma; endophallus with anterior spinous sclerites but lacking posterior rounded sclerites; femora of legs with dark brown band 10
8. Fore wing hyaline *morulops* (Tillyard)
- Fore wing pigmented 9
9. Anterior sclerites of endophallus with three large spines adjacent to posterior sclerites; dorsolateral margin of external valve of gonapophyses straight *melaleucae* New
- Anterior sclerites of endophallus with three spines of different size some distance from posterior sclerites; dorsolateral margin of external valve of gonapophyses convex, apex of lobe bluntly pointed *cochleus* sp. nov.
10. ♀ IO:D = 4.8, ♂ IO:D = 2.6 *pamae* sp. nov.
- ♀ IO:D = 2.8, ♂ IO:D = 1.0 *tillyardi* New

***Peripsocus cochleus* sp. nov.**

Figures 147–56

Peripsocus morulops (Tillyard). New, 1973a: 345.

Material examined. Holotype ♀: Tasmania, Cockle Creek, *Leptospermum lanigerum*, 21 June 1986. Paratype ♂: same data as holotype. Additional records: many individuals collected throughout the year.

Description of female. *Coloration* (after ca 7 years in alcohol). Ground colour of head buff, with the following brown: markings dorsal to eyes, across back of vertex and along each side of black median epicranial suture; postclypeal striae, converging toward pale midline; pair of thin bands extending from eye to antennal socket; maxillary palp; antenna. Ocelli pale, with blackish centripetal margins; tubercle brown surrounded by black margin. Labrum dark brown. Anteclypeus brown in basal third, remainder colourless. Eyes black. Fore wing with shades

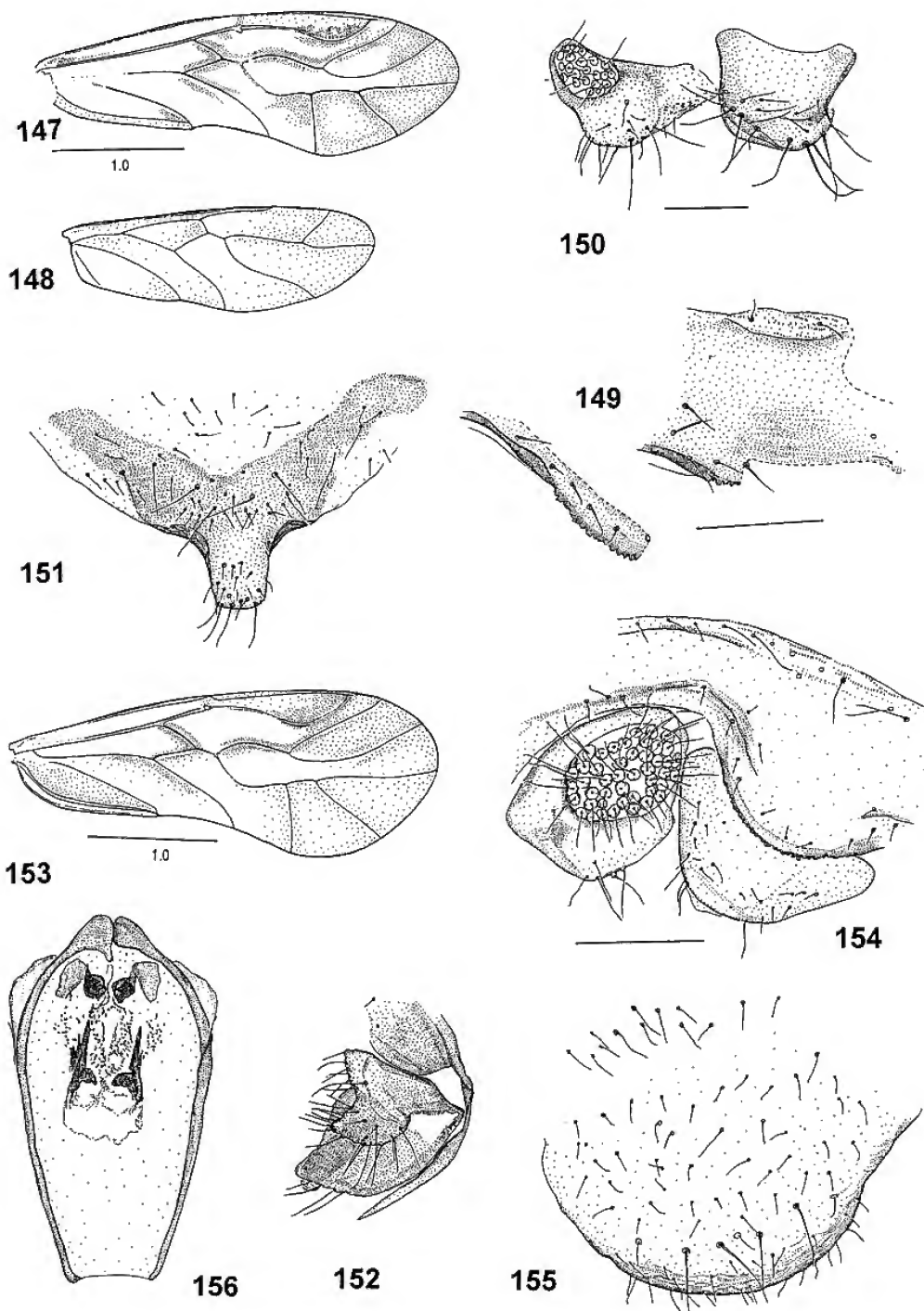
of brown pigment (fig. 147). Veins dark brown, except basally veins *m* and *r*₄₊₅. Hind wing hyaline (fig. 148), with brown tinge in region of radial fork. Thorax dark brown, sutural areas buff dorsally, sutural lines blackish on pleura. Legs: coxae brown, femora pale brown, hind tibia pale brown, tibiae of fore- and mid-legs brown, tarsi brown. Abdomen buff, terga with grey-brown annulations, sterna laterally greyish-brown. Terminal segments brown.

Morphology. IO:D = 3.0. Distal margin of labrum with 5 sensilla, bases very thickened. Distinct row of 4 trichoid sensilla on anterior margin of outer surface of labrum. Suture surrounding ocellar tubercle an extension of median epicranial suture. Vertex-postclypeal suture fusing to anterolateral margins of ocellar tubercle, frons sclerite absent. Clypeal shelf absent. Head with reticulate granular pattern where brown markings occur on vertex and postclypeus. Anterior to median ocellus is an elongated patch filled with reticulate polygonal cells, not granulated. Lacinia apically bifid. Head with small scattered setae. Flagellar segments with fine small setae, placoid sensilla distributed as follows: 3 base *f*₁, 1 apices *f*₄, *f*₆ and *f*₁₀; those of *f*₆ and *f*₁₀ with a filament of medium length. Terminal segment with bluntly pointed apex. Fore wing (fig. 147): veins with sparse short setae; vein *cu*₂ glabrous; veins *rs* and *m* fused for a length. Hind wing (fig. 148) with veins *r* and *m* fused for a length, veins *r* and *m+cu* fused basally. Mesothoracic sterna broad. Claw with subapical tooth, pulvillus fine, flexuous with expanded tip. Rasp and mirror of Pearman's organ well developed. Preapical margin of ninth tergite (fig. 149) bearing a single row of setae, apical margin with small tubercles. Epiproct (fig. 150) strongly setose in apical half. Paraproct (fig. 150) with ovoid field of about 22 trichobothria, posterior margin setose. Subgenital plate (fig. 151): lateral margins of median lobe folded; apex bearing 3–4 long setae, preapically a field of short setae; body of plate bearing 6 long setae in transverse arc; basal pigmented region extending into pair of anteriorly diverging arms; small membranous area medially at apex. Gonapophyses (fig. 152): ventral valve well sclerotised, apex bluntly pointed, spiculate; dorsal valve broad, strongly sclerotised basally next to membranous area, apically bearing 4 setae; external valve with sclerotised inner opening, outer surface of lobe setose in apical half and along dorsolateral margin, apex of lobe appears bluntly pointed due to convex shape of dorsolateral margin.

Dimensions. B 2.3, FW 3.07, HW 2.21, F 0.43, T 0.86, *t*₁ 0.205, *t*₂ 0.111, *rt* 1.9:1, *ct* 17.0, *f*₁ 0.371, *f*₂ 0.284.

Description of male. *Coloration* (after ca 7 years in alcohol). As female, with the following exceptions: eyes purple-black; hind tibia pale brown, merging brown apically; abdomen buff, lacking grey-brown annulations. Fore wing (fig. 153).

Morphology. IO:D = 0.9. Eyes large, reaching beyond level of vertex when looking at side of head. General morphology as in female. Fore wing (fig. 153) as female, costa between base and pterostigma incipiently thickened. Ninth tergite (fig. 154) with well developed curved lobe bearing an apical row of tubercles and a preapical row of setae. Epiproct (fig. 154) basally broad, with basal convex margin. Paraproct (fig. 154) with round field of 45 trichobothria. Hypandrium (fig. 155) with simple rounded apical margin, setose, and possessing a



Figures 147-156. *Peripsocus cochleus* Female: 147, fore wing; 148, hind wing; 149, clunium; 150, epiproct and paraproct; 151, subgenital plate; 152, gonapophyses. Figures 147, 148 and 149-151 to common scales. Male: 153, fore wing; 154, clunium, epiproct and paraproct; 155 hypandrium; 156, phallosome. Figures 154-156 to common scale

preapical row of 4 long setae. Phallosome (fig. 156) with anterior margin of frame not sclerotised. Endophallus with an anterior and posterior pair of sclerites: anterior sclerites each bearing 3 spines of differing lengths, median spine long, lateral spine small and in between one of medium length; posterior pair of sclerites somewhat rounded, apices pointed.

Dimensions. B 1.9, FW 3.10, HW 2.45, F 0.47, T 0.96, t_1 0.284, t_2 0.118, rt 2.4:1, ct 20.0, f_1 0.498, f_2 0.395.

Distribution. Tasmania and Victoria.

Remarks. This locally widespread species is very similar to *Peripsocus morulops* (below). As noted for that species the thickening on the costa of the male fore wing varies. In this species it is not as distinct as in *P. morulops*. This feature, and the overall similarity of male genitalia led New (1973a) to record the Tasmanian specimen of this species as *P. morulops*, noting, however, the darker markings as emphasised in his figure of the fore wing (New, 1973a: 344, fig. 14) of the Tasmanian specimen. The darker brown markings in the fore wing, the different shape of the external valve lobe of the gonapophyses and the clunium bearing a single preapical row of setae distinguish *P. cochleus* from *P. morulops*. The chaetotaxy of the clunium appears uniform in the material examined of both sexes (better developed in males) in the two species. However the figure by New of the male clunium (New, 1973a: 344, fig. 16) shows setae more typically found in the clunium of *P. morulops* (setae in 2 incipient rows). The specimens collected by New (1973a: 345) from Victoria are considerably larger (2.66–2.95 mm, possibly individuals of *P. morulops*?) than those of *P. cochleus* collected from Tasmania. *P. cochleus* was collected largely from *Nothofagus* and mixed forest.

Etymology. An allusion to Cockle Creek, the type locality, through the Latin *cochlea*, a possible origin of “cockle”.

***Peripsocus maoricus* (Tillyard)**

Peripsocopsis maoricus Tillyard, 1923: 194.

Peripsocus maoricus. --- Roesler, 1944: 154.

Peripsocus macropterus Edwards, 1950: 124.

Peripsocus maoricus. --- New, 1973a: 345.

Material examined. Many individuals collected throughout the year.

Distribution. Widely distributed in southern Australia and New Zealand.

Remarks. This locally widespread species was found in most vegetation types.

***Peripsocus melaleucae* New**

Peripsocus melaleucae New, 1971: 224.

Peripsocus melaleucae. --- Cole et al., 1989: 33.

Peripsocus morulops (Tillyard). Cole et al., 1989: 33.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is and Victoria.

Remarks. Locally widespread and predominantly found in coastal scrub (dry and wet) and dry forest; *P. melaleucae* was also found in some rainforest. Examination of the Bass Strait

material indicated that the single male specimen recorded as *P. morulops* is actually *P. melaleucae*; the material recorded as *P. melaleucae* consisted of females only.

***Peripsocus milleri* (Tillyard)**

Peripsocopsis milleri Tillyard, 1923: 195.

Peripsocus milleri. --- Roesler, 1944: 154.

Peripsocus eucalypti Edwards, 1950: 122.

Peripsocus milleri. --- New, 1973a: 346.

Peripsocus sp. PR. Cole et al., 1989: 33.

Material examined. Many individuals collected from February to July.

Distribution. Tasmania, Flinders I (Bass Strait), Victoria, New South Wales, Western Australia, Norfolk I, Lord Howe I, New Zealand and Britain.

Remarks. This locally widespread species was found in both dry and wet forests, and coastal scrub and heath (particularly with species of *Leptospermum*).

***Peripsocus morulops* (Tillyard)**

Figures 157–63

Peripsocopsis morulops Tillyard, 1923: 194.

Peripsocus morulops. --- Roesler, 1944: 154.

Peripsocus morulops. --- New, 1973a: 345.

Peripsocus morulops. --- Cole et al., 1989: 33.

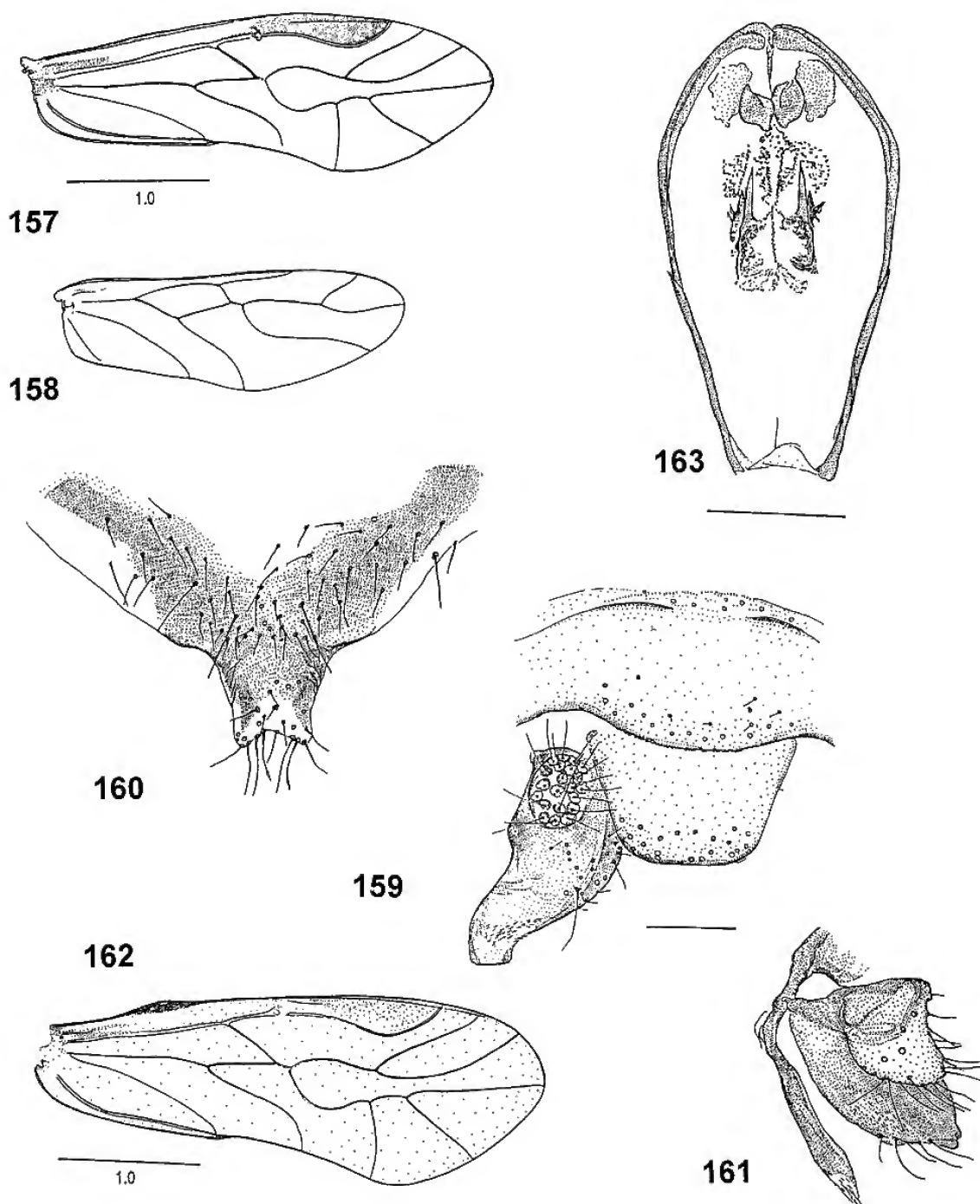
Peripsocus sp. D. Cole et al., 1989: 33.

Smithers (1994b) previously described the female from New South Wales material. The description here of a Tasmanian female, with figures, is provided for comparison with females of *P. cochleus* above.

Material examined. Specimen on which description is based: Tasmania, 1♀, *Dodonaea viscosa*, South Arm Recreation Area, 8 July 1987. Additional records: many individuals collected from January to September.

Description of female. *Coloration* (after ca 6 years in alcohol). Ground colour of head buff, light brown on top of vertex with the following dark brown: confluent markings dorsal to eyes, along back of vertex and each side of blackish median epicranial suture; postclypeal striae, converging towards pale midline; posterior half of anteclypeus; labrum; antenna; maxillary palpi; pair of bands between eye and antennal socket, lower band extending around ventral margin of eye. Gena buff anteriorly, merging light brown posteriorly. Epistomal suture blackish. Ocelli pale with blackish centripetal margins, tubercle brown surrounded by blackish margin. Eyes black. Fore wing (fig. 157): membrane with slight brown tinge; pterostigma with slightly darker cloud in apical half; veins dark brown. Hind wing (fig. 158) hyaline. Thorax dark brown, sutural lines blackish. Legs brown, femur and tarsi slightly darker. Abdomen ventrally buff, dorsal terga with greyish-brown annulations. Terminal segments dark brown.

Morphology. IO:D = 3.4. Distal margin of labrum with 5 sensilla, bases very thickened. Distinct row of 4 trichoid sensilla on anterior margin of outer surface of labrum. Suture surrounding ocellar tubercle an extension of median epicranial suture.



Figures 157-163. *Peripsocus morulops* Female: 157 fore wing; 158, hind wing; 159, clunium, epiproct and paraproct; 160, subgenital plate; 161, gonapophyses. Figures 154, 155 and 157-159 to common scales. Male: 162, fore wing; 163, phallosome.

Vertex-postclypeal suture fusing to anterolateral margins of ocellar tubercle, frons sclerite absent. Clypeal shelf absent. Head with reticulate granular pattern where dark brown markings occur on vertex and postclypeus. Anterior to median ocellus is an elongated patch, filled with reticulate polygonal cells, not granulated. Head bearing small scattered setae. Lacinia apically narrow, incipiently bifid. Flagellar segments bearing fine small setae, placoid sensilla distributed as follows: 3 base f_1 , 1 apices f_4 , f_6 and f_{10} , those on f_6 and f_{10} with a short setiform filament. Terminal segment with bluntly pointed apex. Fore wing (fig. 157): veins with sparse short setae; vein cu_2 glabrous; veins rs and m fused for a short length. Hind wing (fig. 158) with veins r and $m+cu$ fused basally. Mesothoracic sterna broad. Claw with subapical tooth. Pulvillus fine, flexuous, with expanded tip. Rasp and mirror of Pearman's organ well developed. Clunium of ninth tergite (fig. 159) bearing small tubercles, margin bearing 2 incipient rows of preapical setae. Epiproct (fig. 159) with straight transverse apical margin, strongly setose in apical half. Paraproct (fig. 159) with ovoid field of about 22 trichobothria, posterior margin setose. Subgenital plate (fig. 160): median lobe with strongly sclerotised lateral margins; apex bearing 5–6 long setae, preapically a field of short setae; body of plate bearing 4 long setae, 2 medially and 2 anterolaterally; pigmented region surrounding apical membranous area extending into pair of anteriorly diverging arms. Gonapophyses (fig. 161): ventral valve well sclerotised, apex bluntly pointed, spiculate; dorsal valve broad, strongly sclerotised basally next to membranous area, apically bearing 4/5 setae; external valve with sclerotised inner opening, outer surface of lobe setose in apical half and along dorsolateral margin.

Dimensions. B 2.5, FW 3.07, HW 2.33, F 0.54, T 1.00, t_1 0.245, t_2 0.166, rt 1.5:1, ct 14.0, f_1 0.387, f_2 0.237.

Distribution. Tasmania, Deal I (Bass Strait), New South Wales and New Zealand.

Remarks. Smithers (1994b) described the overall coloration of the female as being similar to that of the male (cf. Smithers, 1969), and noted that postclypeal striae were present. The antennae, legs and maxillary palpi were pale brown. There appears to be considerable variation in the extent of coloration, as the Tasmanian females are much darker than those from New South Wales. In comparing the original description of the male by Tillyard (1923) with that of Smithers' (1969) redescription, Tillyard noted that the postclypeus lacked striae whereas Smithers indicated they were faint. Tillyard also noted that the antennae were dark brown, and both the thorax and abdomen blackish. Smithers, however, indicated that both the antennae and thorax were pale brown, and the colour of the abdomen was not mentioned. Postclypeal striae are very obvious on the Tasmanian material and, apart from this and the blackish abdomen, the coloration is most similar to the original description of Tillyard. Tillyard did not mention a costal thickening on the male fore wing between the base and pterostigma and, interestingly, the hind wing (Tillyard, 1923: 195, fig. 19) shows vein $m+cu$ originating separately from vein r at the wing base. The degree of thickening of the costa on the male fore wing appears to vary: in some the length is quite short, but the costa very thick; in others the length is a little longer but the costa not

quite as thick and the posterior margin bears small ripples or undulations. We have shown a male fore wing (fig. 162) for comparison with those of Tillyard (1923), and Smithers (1969). Such thickenings are present, but not as obvious, on the fore wings of males of *P. melaleuca*, *P. bifasciatus* Schmidt and Thornton and *P. cochleus* (see above). The four species appear to be closely related in details of the phallosome, which is nearly identical in all. Differences however can be noted. In *P. melaleuca* the anterior pair of endophallic sclerites each bear 3 large spines [not obvious in the phallosome figured by New (1971: 225, fig. 5)] and are adjacent to the pair of posterior sclerites. The anterior pair of endophallic sclerites of *P. bifasciatus* each bear 3 short spines, and lie a considerable distance from the posterior pair of sclerites. In both *P. morulops* and *P. cochleus* the anterior pair of sclerites each bear 3 spines of differing lengths: a long median spine, a rudimentary lateral spine and, in between, a spine of medium length. A phallosome is shown (fig. 163) of *P. morulops* from a Tasmanian specimen for comparison with those of Smithers (1969) and New (1973a). *P. morulops* differs from *P. cochleus* in details of both fore wing pigmentation and female genitalia (see remarks under *P. cochleus*). *P. morulops* is locally widespread and was found mainly in heath, and in dry coastal scrub and wet scrub.

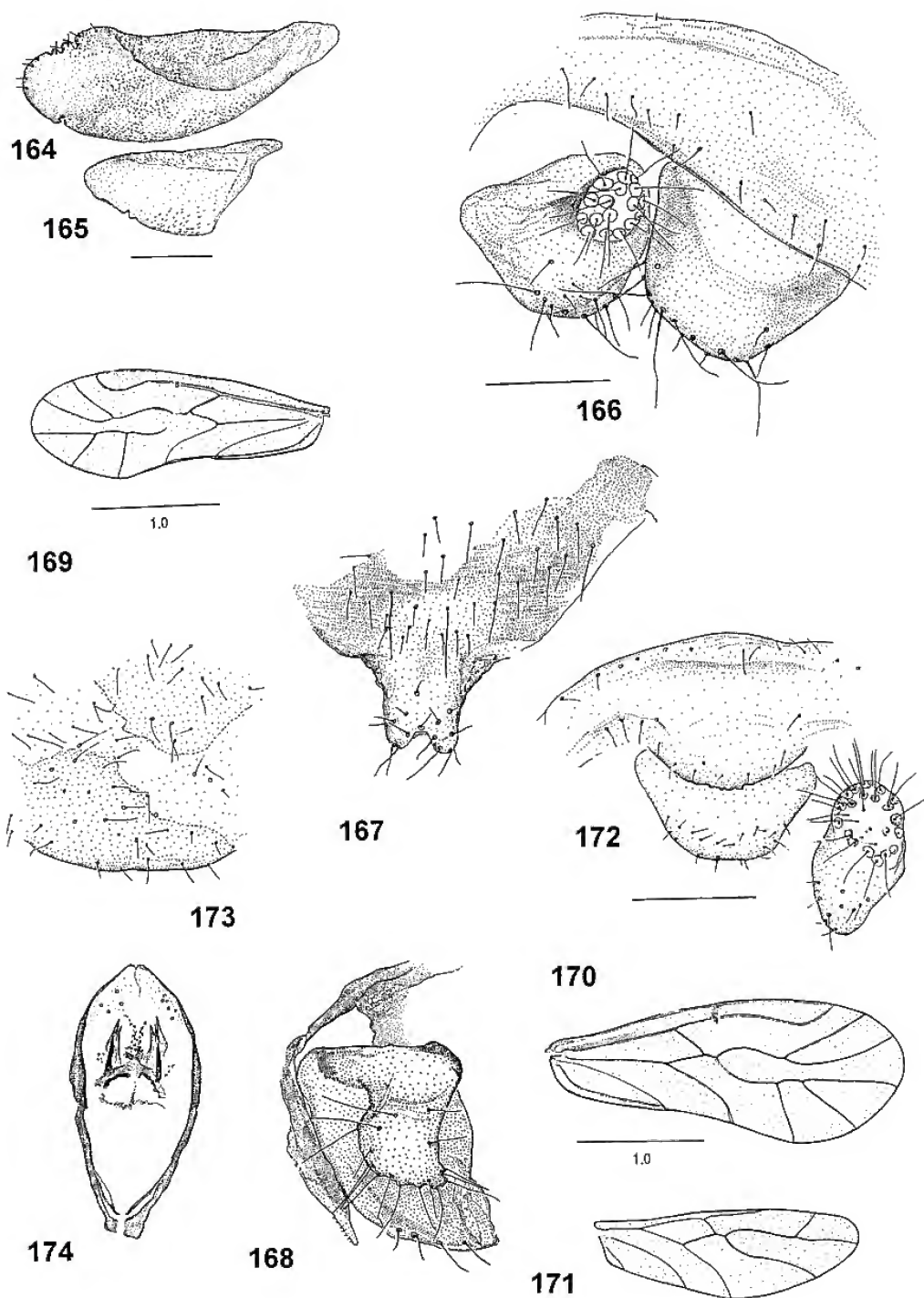
***Peripocus pamae* sp. nov.**

Figures 164–74

Material examined. Holotype micropterous ♀: Tasmania, Banksia scrub, Southwest National Park, Port Davey Tk at Crossing River, 10 Feb 1988. Four nymphs, 4♀ and 4♂ paratypes: same data as holotype. Additional records: many individuals collected throughout the year.

Description of micropterous female. **Coloration** (after ca 5 years in alcohol). Ground colour of head buff, with the following dark brown: confluent markings across back of vertex, dorsal to eyes and on each side of median epicranial suture; postclypeal striae converging towards pale midline; 2 bands between eye and antennal socket, lower band extending below eye towards back of head; basal third of anteclypeus; labrum; 2 apical segments of maxillary palp; ocellar tubercle, anteriorly a squarish patch flanked by postclypeal striae. A light brown patch extending to markings dorsal to eyes lateral to each lateral ocellus. Ocelli pale. Antenna light brown. Eyes black. Fore wing (fig. 164) with slight brown markings. Hind wing (fig. 165) hyaline. Thoracic pleura dark brown, dorsum pale brown. Legs: coxae dark brown; trochanters pale, femora dark brown in basal two-thirds, apical third pale; tibiae pale; tarsi dark brown. Abdomen cream, with grey-brown annulations. Terminal segments dark brown.

Morphology. IO:D = 4.8. Distal margin of labrum with 5 sensilla, bases very thickened. Distinct row of 4 trichoid sensilla on anterior margin of outer surface of labrum. Suture surrounding ocellar tubercle an extension of median epicranial suture. Vertex-postclypeal suture fusing to anterolateral margins of ocellar tubercle, frons sclerite absent. Clypeal shelf absent. Lacinia apically very narrow, apex bifid. Head with very obvious reticulate granular pattern where dark brown markings occur on vertex and postclypeus. Squarish patch anterior to median ocellus filled with reticulate polygonal cells, not granulated. Head bearing small scattered setae. Antenna very short (length



Figures 164-174. *Peripsocus pamae*. Female: 164, fore wing; 165, hind wing; 166, epiproct and paraproct; 167, subgenital plate; 168, gonapophyses; 169, macropterous fore wing. Figures 164, 165 and 166-168 to common scales. Male: 170, fore wing; 171, hind wing; 172, epiproct, paraproct and clunium; 173, hypandrium; 174, phallosome. Figures 170, 171 and 172-174 to common scales.

0.86 mm), flagellar segments bearing setae of differing lengths. Placoid sensilla distributed as follows: 2 base f_1 , 1 apices f_4 , f_6 and f_{10} , those of f_6 and f_{10} bearing a long slender filament. Terminal segment with bluntly pointed apex. Venation of fore wing (fig. 164) and hind wing (fig. 165) absent. Setae small and sparse along apical margin of fore wing. Membranes of both wings densely covered by small apically pointed scales, these being less prominent apical to invaginations on the posterior and anterior margins. Surface of thoracic pleura with reticulate granular pattern, shape of cells varying from polygonal to an elongated spindle. Surface of dorsum lacking pattern, though still very granular. Dorsal lobes not well developed. Claw with subapical tooth, pulvillus fine, flexuous with expanded tip. Rasp and mirror of Pearman's organ well developed. Epiproct (fig. 166) trapezoidal, apical half setose. Paraproct (fig. 166) with round field of 15 trichobothria. Subgenital plate (fig. 167) apically bilobed; few small setae towards apex, and longer setae on body of plate. Gonapophyses (fig. 168).

Dimensions. B 1.7, FW 0.32, HW 0.22, F 0.30, T 0.58, t_1 0.150, t_2 0.111, rt 1.4:1, ct 0.0, f_1 0.150, f_2 0.103.

Description of macropterous female. *Coloration* (after ca 7 years in alcohol). As micropterous female except pigmentation of head less intense, and thorax overall dark brown, sutural areas buff. Fore wing (fig. 169) and hind wing hyaline, veins dark brown. Annulations on abdomen also less intense than those of micropterous females.

Morphology. IO:D = 4.7. General morphology as in micropterous female, except head with less obvious reticulate pattern on brown markings. Antennae slightly longer (length 1.06 mm). Dorsal lobes of thorax well developed, apices of lobes of metathoracic dorsa bearing anastomosing network of small tubercles. Mesothoracic sterna broad. Fore wing (fig. 169): veins with sparse short setae; vein cu_2 glabrous; veins rs and m fused for a length. Hind wing with veins r and m fused for a length, veins r and $m+cu$ fused basally. Genitalia as in micropterous female.

Dimensions. B 1.8, FW 2.15, HW 1.62, F 0.32, T 0.68, t_1 0.166, t_2 0.111, rt 1.5:1, ct 8.0, f_1 0.182, f_2 0.134.

Description of male. *Coloration* (after ca 5 years in alcohol). Head as in micropterous female. Thorax, fore wing (fig. 170) and hind wing (fig. 171) as in macropterous female. Abdomen buff, terminal segments dark brown.

Morphology. IO:D = 2.6. Eyes small, not reaching level of vertex when looking at side of head. General morphology as in macropterous female. Head with obvious reticulate pattern as in micropterous female. Antenna longer than female (length 1.82 mm), dense setae of flagellar segments uniform in length. Lobe of ninth tergite basal to epiproct well developed (fig. 172), apically bearing small broad tubercles, preapically bearing a single row of setae. Epiproct (fig. 172) setose in apical half. Paraproct (fig. 172) with round field of 28 trichobothria. Hypandrium (fig. 173, torn): margin rounded apically, setose; band of pigment broad around apical margin; median indentation absent. Phallosome (fig. 174) frame anteriorly with median unsclerotised region. Endophallic pair of sclerites symmetrical, each consisting of: an anterior transverse sclerite; a longitudinally broad median sclerite

bearing 2-5 apical finger-like projections, the lateral projection being longest and the median projection shortest; a longitudinally narrow lateral sclerite, heavily sclerotised, shorter in length than projections of preceding sclerite. Endophallic pair of lobes membranous, strongly spiculate.

Dimensions. B 1.7, FW 2.65, HW 1.92, F 0.34, T 0.73, t_1 0.190, t_2 0.095, rt 2.0:1, ct 15.0, f_1 0.316, f_2 0.237.

Remarks. In features of the phallosome this species is closely related to *P. tillyardi* and *P. hickmani* New. Micropterous, brachypterous and macropterous females of *P. pamae* have been collected: the brachypterous females possessing the dark brown patches on the head found in micropterous females, and the dark brown well developed thorax of macropterous females. Some brachypterous females possess the dark shading concentrated at the apex of the pterostigma of the fore wing as noted in the description of the holotype of *P. tillyardi* (New, 1973a: 343). *P. hickmani* clearly differs from *P. pamae* in coloration, the shape of the apical median lobe of the subgenital plate and in features of the phallosome, notably in the absence of particular endophallic sclerites and in the shape of the external parameres.

New (1973a: 344) noted that the endophallic sclerites of *P. tillyardi* are asymmetrical. Subsequent examination of the phallosome of the holotype and those of additional material from Victoria and Tasmania indicate that the sclerites are symmetrical, and similar in form to those described above for *P. pamae*. The finger-like projections of the longitudinal median sclerite also vary in number (from 2-5); the longitudinal narrow lateral sclerite, however, is longer, and the apex is in line with the apex of the longest projection of the median sclerite.

Some features of female genitalia have been found to vary. The setae along the dorsolateral margin of the external valve of the gonapophyses in most of the specimens examined are similar to those figured for the holotype. In some individuals, however, the setae extend further along the margin towards the base of the gonapophyses. The number of setae on the apical margin of the dorsal valve varies between 4 and 7, most specimens having only 4. The extent of the bilobed apex of the subgenital plate also varies (depending on the nature of the preparation) to the extent that, in some cases, the apical margin is transverse.

P. pamae differs from *P. tillyardi* in possessing the short lateral longitudinal endophallic sclerite within the phallosome, in coloration, particularly noticeable in the legs, and in possessing small eyes (*P. tillyardi* IO:D - ♀ 2.8, ♂ 1.0). Micropterous and brachypterous females of *P. tillyardi* are thus far unknown. This locally widespread species was found in most vegetation types.

Etymology. Named for Pamela Gaulke, for her friendship and generous hospitality while ERS was in Tasmania.

Peripsocus tillyardi New

Peripsocus tillyardi New, 1973a: 343.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria and New South Wales.

Remarks. This locally widespread species was commonly found in dry coastal scrub and dry forest.

Trichopsocidae

Trichopsocus Kolbe

Trichopsocus Kolbe, 1882a: 25. Type species: *Caecilius hirtellus* McLachlan.

Trichopsocus clarus (Banks)

Caecilius clarus Banks, 1908: 258.

Trichopsocus clarus (Banks). --- Lienhard, 1998: 276.

Trichopsocus australis Edwards, 1950: 119. --- Smithers, 2002: 155.

Material examined. Cataract Gorge, Launceston, *Acacia melanoxylon*, 1♀, 22 July 1986.

Distribution. Cosmopolitan.

Remarks. This species has been collected in Victoria by ERS.

Pseudocaeciliidae

Key to Tasmanian genera of Pseudocaeciliidae

1. Tarsi three-segmented 2
- Tarsi two-segmented 3
2. Fore wing with setae on basal veins in single rank *Howeanum* Smithers
- Fore wing with setae on basal veins in two ranks *Austropsocus* Smithers
3. Fore wing vein *m* two-branched, hind wing veins lacking setae *Mepleres* Enderlein
- Fore wing vein *m* three-branched, setae on apical veins of hind wing 4
4. Fore wing veins with setae sited on dark spots *Cladioneura* Enderlein
- Fore wing veins with setae not sited on dark spots 5
5. Body pale, fore wing hyaline *Chorocaecilius* Li Fasheng
- Body dark, fore wing with strong pattern *Heterocaecilius* Lee and Thornton

Austropsocus Smithers

Austropsocus Smithers, 1962: 930. Type species: *Austropsocus insularis* Smithers.

Key to Tasmanian species of Austropsocus

1. Fore wing with setae on apical veins in single rank *viridis* (Enderlein)

- Fore wing with setae on apical veins in two or more ranks 2
- 2. Fore wing vein *rs* strongly arched, bearing setae in more than two ranks *sinuosus* (Banks)
- Fore wing vein *rs* only slightly curved, bearing setae in two ranks 3
- 3. Maxillary palp buff, apical segment dark brown; male hind tibiae swollen; antennae normal *tibialis* Thornton and New
- Apical segment of maxillary palp no darker than other segments; hind tibiae of male normal; antennae of male with basal flagellar segment much thicker and darker than other segments *antennalis* Thornton and New

Austropsocus antennalis Thornton and New

Austropsocus antennalis Thornton and New, 1977: 24.

Material examined. **Site** 35A, 1♂, 20 Feb 87; 1♀, 6 June 87; **site** 36, 1♂, 21 Feb 87; **site** 119B, 5♀, 22 Feb 88; **site** 139, 1♂, 24 Feb 88; **site** 177, 1♀, 18 June 87; **site** 366E, 2♀, 1 nymph, 16 Feb 88.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and Queensland.

Remarks. *A. antennalis* was taken from dead *Eucalyptus* foliage in wet forest.

Austropsocus sinuosus (Banks)

Zelandopsocus sinuosus Banks, 1939: 441.

Austropsocus sinuosus. --- Thornton and New, 1977: 28.

Material examined. Many individuals collected from March to September.

Distribution. Tasmania, Flinders I (Bass Strait), Victoria, New South Wales, Queensland and South Australia.

Remarks. This autumn–winter locally widespread species was taken from dead *Eucalyptus* foliage of dry and wet forests, dead foliage of mixed forest and some *Nothofagus*.

Austropsocus tibialis Thornton and New

Austropsocus tibialis Thornton and New, 1977: 30.

Austropsocus tibialis. --- Cole et al., 1989: 33.

Austropsocus hyalinus Thornton and New. Cole et al., 1989: 33.

Material examined. **Site** 20, 2♀, 22 May 86; **site** 138, 1♀, 12 June 87; **site** 183, 1♀, 11 Nov 86; 1♀, 17 June 87; **site** 186, 1♂, 27 July 87; **site** 193C, 1♀, 17 June 87; **site** 258, 2♀, 26 Mar 87; 1♀, 27 Apr 87; **site** 269, 16♀, 6♂, 2 nymphs, 1 Mar 88; **site** 272, 1♀, 3 nymphs, 2 Mar 88; **site** 277, 11♀, 5♂, 2 Mar 88; **site** 280A, 1♂, 25 Mar 87; 1♀, 27 Apr 87; 1♀, 22 May 87; 1♀, 29 July 87; **site** 291, 1♂, 4 Mar 88; **site** 294B, 1♀, 2♂, 4 Mar 88.

Distribution. Tasmania, Flinders I (Bass Strait), Victoria, New South Wales and Queensland.

Remarks. Examination of material recorded as *Austropsocus hyalinus* from Flinders I, Bass Strait (Cole et al., 1989) has shown an error in identification. The specimens are conspecific

with Victorian and Tasmanian material of *A. tibialis*. Apart from an isolated southeastern site this essentially autumn species (March to July) was found in northern Tasmania, predominantly in the northwestern Tarkine region, where it was taken from dead foliage of wet and mixed forests, and rainforest (*Nothofagus*).

Austropsocus viridis (Enderlein)

Philotarsus viridis Enderlein, 1903: 309.

Austropsocus viridis. --- Thornton and New, 1977: 32.

Material examined. **Site** 38A, 5♀, 2♂, 2 nymphs, 1 Oct 86; **site** 40, 12 ♀, 5♂, 10 nymphs, 30 Sep 86; 1♀, 23 Apr 87; **site** 184, 1♂, 27 Aug 86; 3♀, 7♂, 1 nymph, 15 June 87.

Distribution. Tasmania, Victoria, New South Wales and Queensland.

Remarks. Apart from some exotic vegetation at Launceston this species was collected only at Hobart.

Chorocaecilius Li Fasheng

Chorocaecilius Li Fasheng, 2000: 20. Type species: *Heterocaecilius diogenes* Lee and Thornton.

Chorocaecilius brunellus (Tillyard)

Caecilius brunellus Tillyard, 1923: 188.

Pseudocaecilius brunellus. --- Lee and Thornton, 1967: 111.

Heterocaecilius diogenes Lee and Thornton, 1967: 109.

Heterocaecilius brunellus. --- New, 1974a: 69.

Chorocaecilius diogenes. --- Li Fasheng, 2000: 20.

Chorocaecilius brunellus. --- Lienhard and Smithers, 2002: 301.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and New Zealand.

Remarks. *C. brunellus* was most common on *Nothofagus*, but was numerous and taken on many occasions from mixed forest, wet scrub, dry forest and dry coastal scrub (particularly *Melaleuca ericifolia*) habitats. The species is locally widespread.

Cladioneura Enderlein

Cladioneura Enderlein, 1906: 404. Type species: *Cladioneura pulchripennis* Enderlein.

Cladioneura pulchripennis Enderlein

Cladioneura pulchripennis Enderlein, 1906: 405.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria and New South Wales.

Remarks. This species was found in several types of vegetation, particularly from low vegetation sites of heath and scrub (dry and wet) and also from rainforest (*Nothofagus*). *C. pulchripennis* is locally widespread.

Heterocaecilius Lee and Thornton

Heterocaecilius Lee and Thornton, 1967: 13. Type species: *Heterocaecilius minotus* Lee and Thornton.

Heterocaecilius lachlani (Enderlein)

Pseudocaecilius lachlani Enderlein, 1903: 263.

Heterocaecilius lachlani. --- Schmidt and Thornton, 1993: 179.

Material examined. Many individuals collected from January to September.

Distribution. Tasmania, Flinders I (Bass Strait), Victoria and New South Wales.

Remarks. With the exception of exotic vegetation at Mt Field NP (site 321A) all individuals of this species were collected from northeastern Tasmania. Essentially restricted to the coast *H. lachlani* was found from Friendly Beaches to Asbestos Range NP, predominantly at sites at Eddystone Point and in Mt William NP. *H. lachlani* was taken from heath and coastal scrub, and *Casuarina stricta*.

Howeanum Smithers

Howeanum Smithers, 1995: 4. Type species: *Howeanum huberi* Smithers.

Key to Tasmanian species of *Howeanum*

1. Endophallic sclerites of phallosome basally narrow
..... *costale* (Thornton and New)
- Endophallic sclerites of phallosome basally broad (female unknown) *tasmaniensis* sp. nov.

Howeanum costale (Thornton and New)

Austropsocus costalis Thornton and New, 1977: 36.

Howeanum costale. --- Schmidt and Smithers, 2004: 14.

Material examined. **Site** 57, 1♀, 18 Feb 88; **site** 60, 1♀, 18 Feb 88; **site** 164B, 1♀, 19 Apr 87; **site** 207, 1♀, 20 May 87; **site** 246, 1♀, 1♂, 2 nymphs, 24 Aug 86; 15♀, 2♂, 25 Oct 86; 5♀, 2♂, 4 nymphs, 24 Jan 87; 16♀, 3♂, 1 Mar 87; 1♀, 30 July 87; 3♀, 2♂, 3 Mar 88; **site** 251, 1♀, 24 Jan 87; **site** 252B, 8♀, 1♂, 1 nymph, 24 Jan 87; 1♀, 1 Mar 87; 1♂, 4 nymphs, 30 July 87; **site** 253, 1♀, 23 Oct 86; **site** 255, 1♂, 1 nymph, 27 June 87; **site** 353, 2♀, 1♂, 21 Mar 88.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and Queensland.

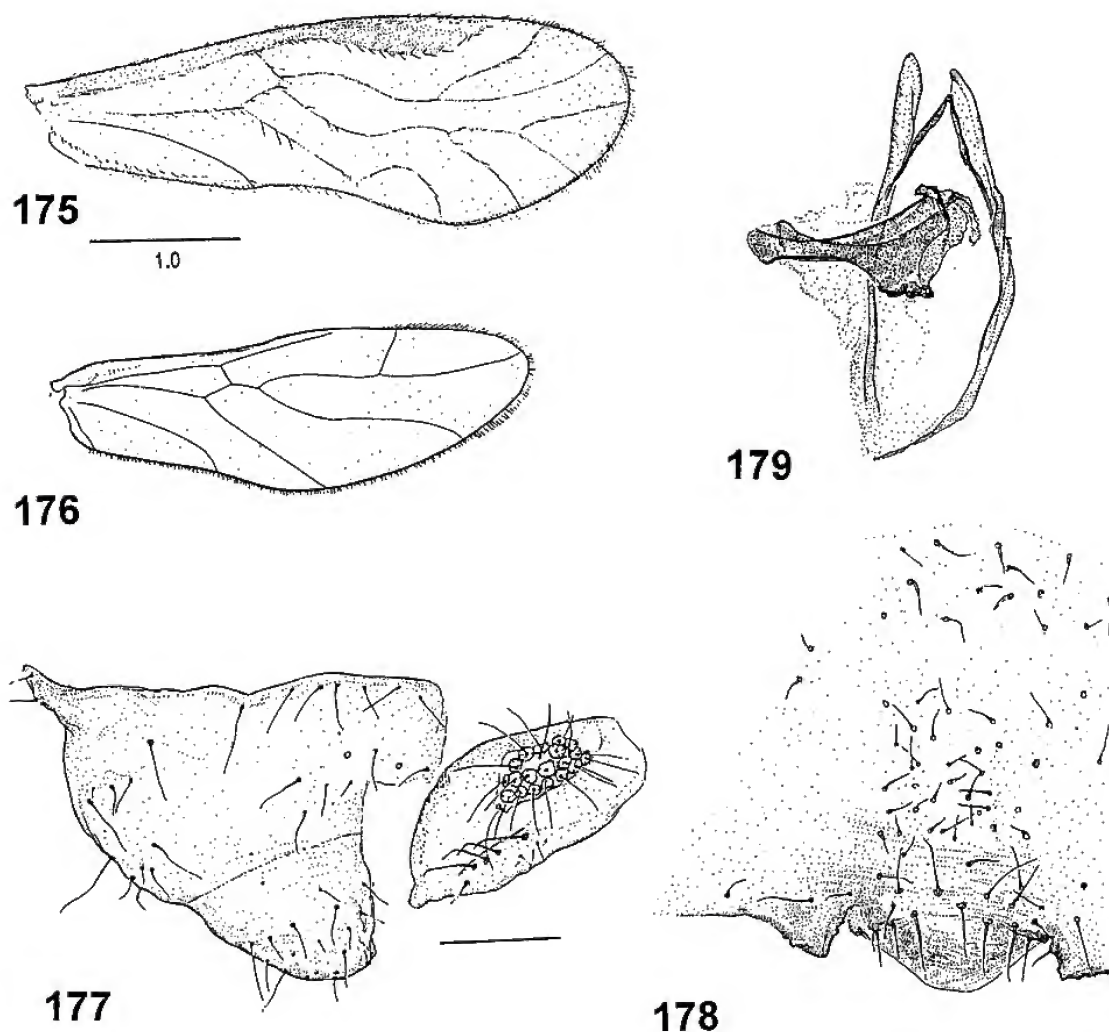
Remarks. This species was mainly found in coastal scrub (dry and wet) and in the heath understorey of *Eucalyptus* and *Banksia serrata*.

Howeanum tasmaniensis sp. nov.

Figures 175–79

Material examined. Holotype ♂: Tasmania, Mt Maurice walking track, *Eucalyptus* foliage, 10 Nov 1986.

Description of male. **Coloration** (after ca 7 years in alcohol, slightly teneral). Creamy-buff, with barely discernible darker



Figures 175-179. *Howeanum tasmaniensis*. Male: 175, fore wing; 176, hind wing; 177, epiproct and paraproct; 178, hypandrium; 179, phallosome. Figures 175, 176 and 177-179 to common scales.

markings dorsal to eyes, along each side of median epicranial suture and on postclypeus, striae converging towards pale midline. Ocelli with dark brown centripetal margins. Eyes black. Fore wing (fig. 175) and hind wing (fig. 176) hyaline.

Morphology. IO:D = 3.0. Eyes small, below level of vertex when looking at side of head. Head and thorax glossy. Median epicranial suture not distinct. Postclypeus not bulbous. Flagellar segments bearing dense long thin setae, sensory placoids distributed as follows: 2 small, somewhat apart near base of f_1 , 1 at apex of f_4 , 1 near apices f_6 and f_{10} ; those of f_6 and f_{10} bearing a long slender filament. Surface of flagellar segments very

undulating, more prominent on apical segments. Terminal segment with elongated narrow apex. Fore wing (fig. 175): setae in single rank on veins; posterior margin of pterostigma bearing 2 ranks; vein cu_2 glabrous; veins rs and m joined by a short cross-vein. Hind wing (fig. 176) margin bearing long setae around apex to vein m , remainder of posterior margin bearing alternating setae of short and intermediate length. Claw lacking subapical tooth, pulvillus broad. Rasp and mirror of Pearman's organ well developed. Epiproct and paraproct (fig. 177), latter with round field of 18 trichobothria. Hypandrium (fig. 178) with a large median and on each side smaller apical lateral lobes.

Phallosome (fig. 179) with pair of endophallic sclerites basally broad.

Dimensions. B 2.2, FW 3.66, HW 2.95, F 0.54, T 1.11, t_1 0.379, t_2 0.071, t_3 0.079, rt 5.3:1:1.1, ct 16:0:0, f_1 0.632, f_2 0.355.

Female. Unknown.

Remarks. *Howeanum tasmaniensis* is similar to *H. costale* in the fore wing veins bearing a single rank of setae. It differs from *H. costale* in the shape of the endophallic sclerites – being basally narrow in *H. costale* and basally broad in *H. tasmaniensis*.

Etymology. From Tasmania.

Mepleres Enderlein

Mepleres Enderlein, 1926: 61. Type species: *Mepleres maeandricus* Enderlein.

Key to Tasmanian species of *Mepleres*

1. Body pale, fore wing hyaline *rotundatus* (New)
- Body dark, fore wing with strong pattern *tanei* (Smithers)

***Mepleres rotundatus* (New)**

Pseudoscottiella rotundata New, 1974a: 67.

Meniscopsocus rotundatus. --- Li Fasheng, 1993: 382

Mepleres rotundatus. --- Yoshizawa, 2000: 674.

Material examined. Many individuals collected occasionally throughout the year.

Distribution. Tasmania, Victoria and New South Wales.

Remarks. This species was found only on *M. insulare* and *A. melanoxylo*n at some sites in eastern, northern and northwestern Tasmania.

***Mepleres tanei* (Smithers)**

Pseudoscottiella tanei Smithers, 1977: 279.

Meniscopsocus tanei. --- Li Fasheng, 1993: 382

Mepleres tanei. --- Yoshizawa, 2000: 674.

Material examined. Site 35A, 3♀, 20 Feb 87; site 46, 1♀, 3 Nov 86; site 159B, 1♀, 23 Mar 87.

Distribution. Tasmania, Victoria and New South Wales.

Philotarsidae

Key to Tasmanian genera of Philotarsidae

1. Antenna flagellar segments uniformly pigmented 2
- Antenna flagellar segments with white apices *Aaroniella* Mockford
2. Fore wing vein cu_2 bare 3
- Fore wing vein cu_2 setose *Philotarsopsis* Tillyard
3. Fore wing with strong pattern *Abelopsocus* gen. nov.
- Fore wing hyaline *Haplophallus* Thornton

***Aaroniella* Mockford**

Aaroniella Mockford, 1951: 102. Type species: *Elipsocus maculosus* Aaron.

***Aaroniella rawlingsi* Smithers**

Aaroniella rawlingsi Smithers, 1969: 324.

Material examined. Many individuals collected from January to August.

Distribution. Southern Australia and New Zealand.

Remarks. This locally widespread species was taken from a range of habitats including dry forest, dry coastal scrub, heath and some rainforest. It was absent in spring and early summer.

***Abelopsocus* gen. nov.**

Diagnosis. Belonging to the Philotarsidae Pearman (1936) as defined by Thornton (1981). Fore wing: slipper-shaped, strongly pigmented, vein cu_2 glabrous. Hind wing: with slight pigmented regions, particularly around posterior margin; vein cu_1 glabrous; veins r_{4+5} and m setose. Female antennae: flagellar segments long, slender; setae on segments short, sparse and uniform in length; terminal segment with long apical seta. Male antennae: flagellar segments long, slender; setae on segments very long; terminal segment lacks both the attenuated apex and the long apical seta. Subgenital plate lobe bearing small apical setae. Dorsal valve of gonapophyses sub-rectangular, external valve trianguloid. Hypandrium incipiently bilobed posteriorly. Phallosome simple, frame ovoid without sclerites.

Type species: *Latrobiella fenestrata* Schmidt and Thornton.

Remarks. Thornton (1981) applied principal co-ordinates analysis on selected characters to identify groups of philotarsid species, which subsequently formed the basis for establishing *Latrobiella*. The two New Zealand species, *Aaroniella parda* Thornton, Wong and Smithers and *Aaroniella basipunctata* Thornton, Wong and Smithers, did not associate consistently with any group. Thornton placed both species in *Latrobiella*, regarding them as aberrant members of the genus. Along with the recently described *Latrobiella fenestrata* and a new species here described below they now appear to form a close-knit species group within *Philotarsopsis* (of which *Latrobiella* is a synonym). The four species possess features in common contrasting them from other species within the genus. The fore wings are strongly pigmented, and vein cu_2 glabrous. The flagellar segments of the antennae are long and slender. In contrast, other species of *Philotarsopsis* possess nearly hyaline fore and hind wings, and vein cu_2 of the fore wing is setose. The antennae are shorter and segments thicker. The setae on the female flagellar segments vary in length and thickness, those of the male are short, dense and uniform. On the terminal segment both sexes possess an attenuated apex with a long apical seta.

Of the four species, *parda* is the most distinctive as it possesses antennal segments with white apices and the female has an attenuated apex (as does *basipunctata*) on the terminal segment. The subgenital plate lobe has two long apical setae, and the external valve of the gonapophyses is oval. The

hypandrium apex is smoothly rounded. Both *fenestrata* and *basipunctata* have fore wing setae sited on dark spots, but in the latter species the spots are only in the basal half of the wing. The Chilean species *P. cruciclypeus* (New and Thornton) has features which place it between the two groups of species. The female antennal apex is attenuated, bearing a long seta (New and Thornton 1981: 165, fig. 58 – noted incorrectly as the apical segment of male antenna) and the flagellar setae appear uniform and short. The flagellar setae of the male (New and Thornton 1981: 165, fig 57 – noted incorrectly as the apical segment of the female antenna) are long, the apex not attenuated but bearing a long seta. The lengths of the 2 basal flagellar segments suggest the antenna is long and slender. Vein cu_2 is glabrous, but the fore wing is not pigmented. On the balance of diagnostic features however, *cruciclypeus*, along with *parda*, *basipunctata*, and *fenestrata*, are here formally transferred to *Abelopsocus*.

Etymology. The generic name is a combination of the name Abel, after the Dutch seafarer, explorer, and merchant Abel Tasman, and *Psocus*, a genus of Psocidae.

Abelopsocus basipunctatus (Thornton, Wong and Smithers) comb. nov.

Aaroniella basipunctata Thornton, Wong and Smithers, 1977: 204.

Latrobiella basipunctata. --- Thornton, 1981: 433.

Philotarsoptis basipunctata. --- Lienhard and Smithers, 2002: 334.

Distribution. New Zealand.

Abelopsocus cruciclypeus (New and Thornton) comb. nov.

Haplophallus cruciclypeus New and Thornton, 1981: 164.

Latrobiella cruciclypeus. --- Thornton, 1981: 433.

Philotarsoptis cruciclypeus. --- Lienhard and Smithers, 2002: 334.

Distribution. Chile.

Abelopsocus pardus (Thornton, Wong and Smithers) comb. nov.

Aaroniella parda Thornton, Wong and Smithers, 1977: 201.

Latrobiella parda. --- Thornton, 1981: 434.

Philotarsoptis parda. --- Lienhard and Smithers, 2002: 336.

Distribution. New Zealand.

Key to Tasmanian species of *Abelopsocus*

1. Fore wing setae sited on dark spots *fenestratus* (Schmidt and Thornton)
- Fore wing setae not sited on dark spots *truganinia* sp. nov.

Abelopsocus fenestratus (Schmidt and Thornton) comb. nov.

Latrobiella fenestrata Schmidt and Thornton, 1993: 188.

Philotarsoptis fenestrata. --- Lienhard and Smithers, 2002: 335.

Material examined. **Site** 130, 1♀, 20 Apr 87; **site** 159A, 1♂, 5 June 86; 1♀, 2♂, 11 July 86; 1♂, 9 Aug 86; 1♀, 1♂, 12 Sep 86; 1♀, 1 nymph, 8 Nov 86; 1♀, 6 nymphs, 7 Dec 86; 1♂, 4 nymphs, 18 Jan 87; 1♀, 2 nymphs, 5 Feb 87; 1♂, 1 nymph, 23 Mar 87; 1♂, 19 Apr 87; 1♂, 25 July 87; 1♀, 1 nymph, 23 Feb 88; **site** 159C, 1♀, 12 May 87; **site** 194B, 1♀, 1 nymph, 17 June 87; **site** 246, 1♂, 26 Mar 87; **site** 258, 1♀, 27 Apr 87; **site** 268, 2♂, 1 nymph, 1 Mar 88; **site** 281, 1♂, 1 nymph, 24 Oct 86; 2♀, 26 Jan 87; 2♂, 25 Mar 87; 2♀, 1♂, 27 Apr 87; 1♀, 1♂, 22 May 87.

Distribution. Tasmania and Victoria.

Remarks. This species, which was found throughout the year, was taken mainly from two very different habitats: *Casuarina stricta* (site 159A) and a rainforest consisting predominantly of *Phyllocladus asplenifolius* and *Anodopetalum biglandulosum* (site 281).

Abelopsocus truganinia sp. nov.

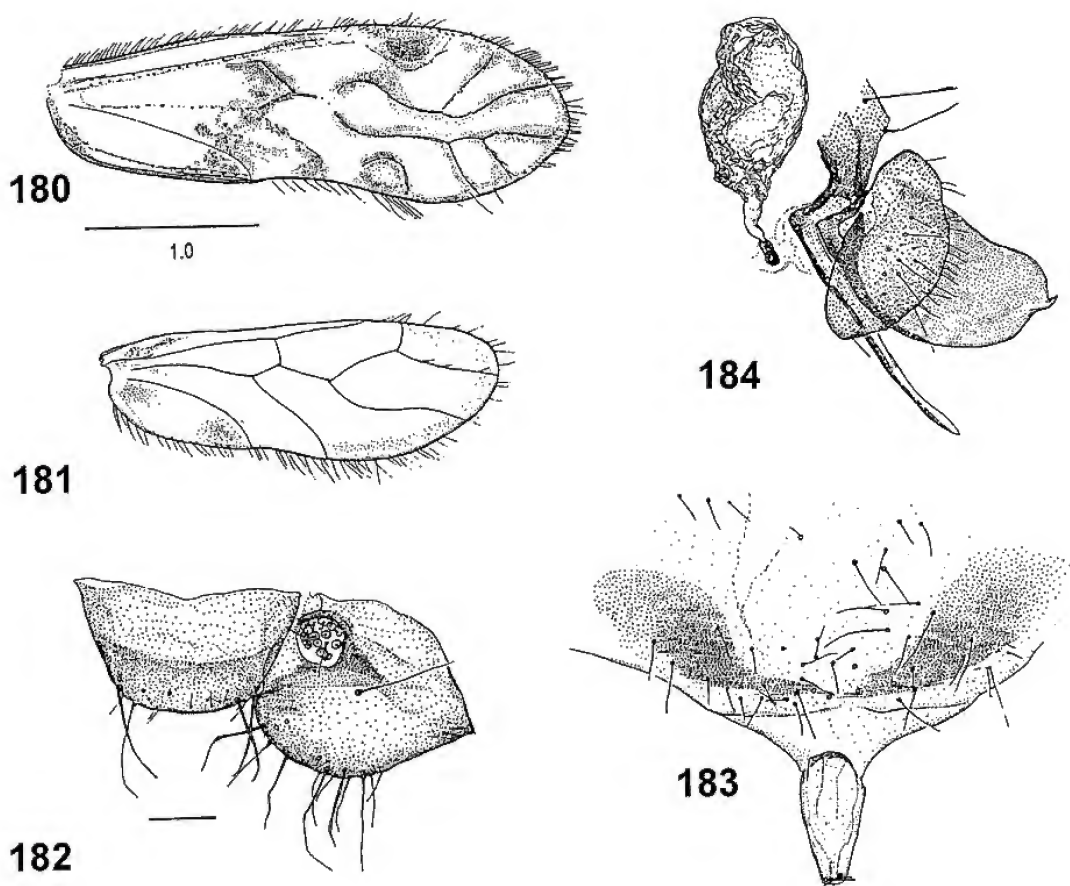
Figures 185–94

Latrobiella sp. B. Coy et al., 1993: 77.

Material examined. Holotype ♀: Tasmania, Mt Field National Park, dead rainforest foliage, 3 Apr 1987. Paratype ♂: dead rainforest foliage, 3 Mar 1988. Additional records: **Site** 10, 2♀, 21 Nov 86; **site** 18, 1♀, 18 Nov 86; **site** 175, 1♀, 26 Apr 87; **site** 209, 1♀, 17 Apr 87; 1♀, 20 May 87; **site** 281, 1♀, 25 Nov 86; 1♀, 22 May 87; **site** 360, 2♀, 4 nymphs, 24 Mar 88; Big Sassy Ck, Site 1, PKD Sassafras, 2♀, 9 nymphs, 12 May 89 (J. Diggle); Big Sassy Ck, Site 2, PKD Sassafras, 2♀, 12 nymphs, 12 May 89 (P. Greenslade).

Description of female. **Coloration** (after ca 6 years in alcohol). Ground colour buff, with the following dark brown: round patch on each side of vertex, surrounded by markings (some confluent) dorsal to eyes, across back of vertex and along each side of median epicranial suture; squarish patch centrally on frons extending from median ocellus to epistomal suture; postclypeal striae converging towards midline; markings adjacent to posterior margin of gena; basal half of anteclypeus; labrum; apical segment of maxillary palp; antenna. Greyish-brown markings as follows: short band extending from eye to anterior margin of antennal socket; band extending from lateral ocellus along lateral epicranial arm, not reaching preceding band; patch on each side of frons between mid-line and antennal socket. Ocelli pale, with blackish centripetal margins. Eyes black. Fore wing with brown pigmented areas (fig. 185). Hind wing (fig. 186) hyaline, with pale brown band around posterior margin, cell cu_2 brown. Thorax dark brown, sutural areas buff. Legs with coxae dark brown, femora and tibia buff, tarsi brown. Abdomen buff, with extensive greyish-brown annulations. Terminal segments dark brown.

Morphology. IO:D = 3.0. Distal margin of labrum bearing 11 sensilla, each lateral sensillum posterior to remaining sensilla, anterior margin of outer surface with distinct row of 4 sensilla. Epistomal suture present; clypeal shelf absent, however narrow remnant appears present on lateral margins of epistomal suture. Lacinia with large apical lateral projection. Head with reticulate pattern, surface slightly granulated. Patch centrally on frons anterior to median ocellus with large polygonal-shaped cells, not granulated, and in cross-section the apically round margins protrude beyond the surface. Vertex and frons bearing scattered



Figures 180-184. *Philotarsopsis hellyeri*. Female: 180, fore wing; 181, hind wing; 182, epiproct and paraproct; 183, subgenital plate; 184, gonapophyses and spermathecal sac. Figures 180, 181 and 182-184 to common scales.

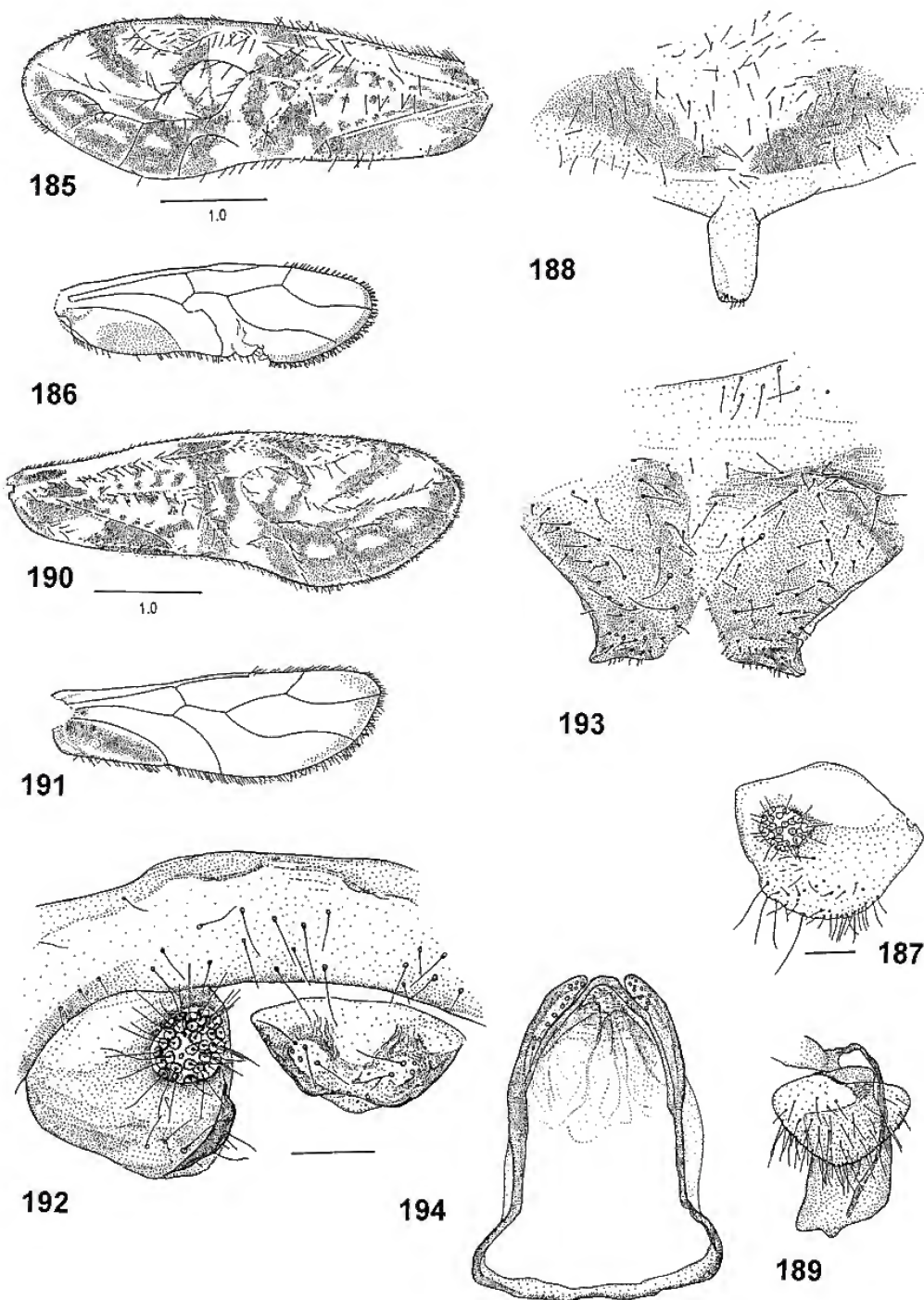
thick large setae, these associated with smaller fine setae on postclypeus. Gena with small region of small fine setae. Antennae with very slender flagellar segments bearing small sparse setae, these becoming longer in apical segments. Ten flagellar segments present, f_{10} and f_{11} fused. Placoid sensilla distributed as follows: 2 base f_1 , 1 apex f_4 . Trichoid sensillum near apex of f_6 and near centre of f_{10} , each bearing a long slender filament. Terminal segment narrowing apically, not attenuated, bearing long apical seta. Fore wing (fig. 185): basal veins bearing 2 ranks of long thick setae, staggered in arrangement; vein cu_2 glabrous; medial and radial veins, and vein cu_{1b} bearing a single rank of long thick setae, and a second rank of short fine setae. Two setae on membrane basally in cell R_5 , 3 setae basally in cell M_3 . Pterostigma granular, strongly setose. Setae on hind wing (fig. 186) veins: r_1 2 (small), rs 0, r_{2+3} 0, r_{4+5} 16, m 11, cu_1 0; those on r_{4+5} and m in 2 ranks. Both wings densely covered by microtrichia. Claw with subapical tooth, pulvillus fine with expanded tip. Rasp

and mirror of Pearman's organ well developed. Epiproct setose in apical half. Paraproct (fig. 187) with round field of 24 trichobothria. Subgenital plate (fig. 188) apical sclerite bearing 11 small setae on distal margin, anteriorly diverging pigmented arms well developed. Gonapophyses (fig. 189): ventral valve long, slender, apically with recurrent spinelets; dorsal valve with sclerotised basal bar, rudimentary spine on distal margin apically rounded, bearing recurrent spinelets; external valve subtriangular, rounded posteriorly, setose.

Dimensions. B 2.8, FW 4.19, HW 2.95, F 0.65, T 1.27, t_1 0.395, t_2 0.079, t_3 0.103, rt 5:1:1.3, ct 17.0, f_1 0.466, f_2 0.419.

Description of male. **Coloration.** (after ca five years in alcohol). As female. Fore wing (fig. 190), hind wing (fig. 191) hyaline except for slight apical shading and darkened anal field.

Morphology. IO: D = 2.5. Eyes below level of vertex when looking at side of head. Antenna flagellar segments thicker,



Figures 185-194. *Abelopsocus truganinae*. Female: 185, fore wing; 186, hind wing; 187, paraproct; 188, subgenital plate; 189, gonapophyses. Figures 185, 186 and 187-189 to common scales. Male: 190, fore wing; 191, hind wing; 192, epiproct and paraproct; 193, hypandrium; 194, phallosome. Figures 190, 191 and 192-194 to common scales.

and flagellar setae much longer than those in female. Segments f_{10} and f_{11} fused as in female. Distribution of sensilla as in female except base of f_1 bearing 1 placoid. Terminal segment not attenuated, apex lacking large seta. Fore wing (fig. 190) as in female, except setae on membrane basally in cell M_3 absent. Setae on hind wing (fig. 191) veins: r_1 3, rs 0, r_{2+3} 0, r_{4+5} 21, m 16, cu_1 0; those on r_{4+5} and m in 2 ranks. Epiproct (fig. 192) with pair of lobes, each bearing 4/5 long setae and 1 small seta. Paraproct (fig. 192) with round field of 33 trichobothria and 2 setae not in rosettes. Hypandrium (fig. 193) basally incised, apically emarginate with a pair of bluntly pointed curved hooks. Phallosome (fig. 194): frame anteriorly transverse; endophallus consisting of median and lateral pairs of membranous lobes.

Dimensions. B 2.7, FW 4.01, HW 2.98, F 0.63, T 1.32, t_1 0.442, t_2 0.087, t_3 0.103, rt 5.1:1:1.2, ct 18.0:0, f_1 0.750, f_2 0.608.

Remarks. *A. truganinae* can be distinguished from *A. fenestratus* by the fore wing setae not being sited on dark spots, and in the form of the male epiproct; from *A. pardus* in the form of the subgenital plate, male epiproct and hypandrium; from *A. basipunctatus* in the fore wing pigmentation, and in the form of the male epiproct and hypandrium. *A. truganinae* is essentially a rainforest species that was taken in November and in the autumn months.

Etymology. Named for Truganini, considered to be the last surviving full-blood indigenous person from Tasmania.

Haplophallus Thornton

Haplophallus Thornton, 1959: 336. Type species: *Haplophallus orientalis* Thornton.

Haplophallus sinus Thornton and New

Haplophallus sinus Thornton and New, 1977: 20.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and Queensland.

Remarks. Essentially confined to the coastal rim of Tasmania *H. sinus* was very common in dry forest, dry coastal scrub and heath.

Philotarsopsis Tillyard

Philotarsopsis Tillyard, 1923: 182. Type species: *Philotarsopsis delicata* Tillyard.

Latrobiella Thornton, 1981: 433. --- Lienhard and Smithers, 2002: 334.

Key to Tasmanian species of Philotarsopsis

1. Rudimentary spine of dorsal valve of gonapophyses with sharply pointed apex, basal portion of spermathecal duct sclerotised (males unknown) *hellyeri* sp. nov.
- Rudimentary spine of dorsal valve of gonapophyses with rounded apex, basal portion spermathecal duct membranous 2

2. Line of dark pigment from ocellar protuberance to antennal socket; pigment on prothorax distinctly darker than that on mesothorax; areola postica less than one third covered with brown cloud, fore wing fascia distinct *paraguttata* (Thornton and New)
- No dark line from antennal socket to ocellar protuberance; prothorax no darker than mesothorax; areola postica at least two-thirds covered with brown cloud, fore wing fascia broken or indistinct *guttata* (Tillyard)

Philotarsopsis guttata (Tillyard)

Philotarsis guttatus Tillyard, 1923: 181.

Philotarsopsis delicatus Tillyard, 1923: 182.

Philotarsis greyi Edwards, 1950: 116.

Haplophallus guttatus. --- Smithers, 1969: 322.

Latrobiella guttata. --- Thornton, 1981: 433.

Philotarsopsis guttata. --- Lienhard and Smithers, 2002: 335.

Latrobiella lemsidia Thornton and New. Cole et al., 1989: 34.

Material examined. Many individuals collected from January to July.

Distribution. Tasmania, Bass Strait Is, all mainland states (except Northern Territory) and New Zealand.

Remarks. This species was collected mainly in dry and wet forests with an understorey of sclerophyllous shrubs. Examination of the material recorded as *Latrobiella lemsidia* from the Bass Strait Is (Cole et al., 1989) shows this material to be conspecific with Victorian and Tasmanian specimens of *Philotarsopsis guttata*.

Philotarsopsis hellyeri sp. nov.

Figures 180–84

Material examined. Holotype ♀: Tasmania, Cradle Mtn, Cradle Valley above Weindorfers grave, 41°38'S 145°57'E, fogging *Nothofagus cunninghamii*, 25 Feb 1990 (R. Coy, P. Lillywhite, A. Yen). Twenty-five ♀ paratypes: same data as holotype (MV).

Description of female. **Coloration** (after ca 3 years in alcohol). Head ground colour buff, with the following dark brown: confluent markings dorsal to eyes, along back of vertex and along each side of blackish median epicranial suture; large patch centrally on frons, extending to include background of ocelli; ring surrounding antennae base; lateral margins of postclypeus; basal half of anteclypeus; labrum; apical segment of maxillary palp. Gena buff ventrally, merging brown dorsally. Scape and pedicel dark brown, basal flagellar segment light brown, apically merging dark brown, remainder of flagellar segments dark brown. Ocelli pale, centripetal margins blackish. Eyes black. Fore wing (fig. 180) with brown markings, veins dark brown, membrane with pale brown tinge. Hind wing (fig. 181) membrane with pale brown tinge. Thorax dark brown, sutural areas pale on dorsa. Legs with coxa dark brown, femur and tibia pale brown, tibia merging brown apically, tarsi dark brown. Abdomen buff, terga with lateral grey-brown annulations, terminal segments dark brown.

Morphology. IO:D = 2.9. Distal margin of labrum bearing 11 sensilla, each lateral sensillum posterior to remaining sensilla, anterior margin of outer surface with distinct row of

four sensilla. Epistomal suture present, clypeal shelf absent, but narrow remnant appears present on lateral margins of epistomal suture. Lacinia with apical lateral projection larger than median. Postclypeal striae not distinct. Vertex of head with obvious reticulate pattern, surface of head strongly granulated except patch of polygonal cells centrally on frons anterior to median ocellus. Vertex, frons and gena bearing setae of two lengths, one short and narrow, the other thick and very long. Postclypeus bearing short narrow setae. Antennae flagellar segments bearing setae of differing lengths, placoid sensilla distributed as follows: 1 base f_1 , 1 apex f_4 . Trichoid sensillum near apices of f_6 and f_{10} , each bearing a long slender filament. Terminal segment apically attenuated, bearing large apical seta. Fore wing (fig. 180) veins, including cu_2 , bearing single rank of large setae. Medial and radial veins, and vein cu_{1b} bearing a second rank of shorter fine setae. Costa adjacent to pterostigma strongly thickened. Setae on hind wing (fig. 181) veins: r_1 1, rs 0, r_{2+3} 0, r_{4+5} 10 (2 ranks), m 12 (2 ranks), cu_1 1. Both wings with microtrichia on margins and membranes. Ninth tergite with central reticulate field of polygonal cells. Epiproct (fig. 182) with 2 large setae at each posterolateral margin. Paraproct (fig. 182) with round field of 13–17 trichobothria. Subgenital plate (fig. 183): lobe elongated, narrowing posteriorly, apex with 4–5 small setae; pigment band extending into pair of anteriorly diverging arms. Gonapophyses (fig. 184): ventral valve long, slender; dorsal valve broad with sclerotised basal bar, rudimentary spine apically pointed; external valve transverse, posterior margin shallowly rounded, setose. Spermathecal sac (fig. 184) membranous, basal portion of duct sclerotised.

Dimensions. B 3.0, FW 2.83, HW 2.18, F 0.63, T 1.17, t_1 0.427, t_2 0.071, t_3 0.111, rt 6:1:1.5, ct 12.0/0, f_1 0.411, f_2 0.253.

Male. Unknown.

Remarks. This species, found only on *Nothofagus* from Cradle Valley, is similar to *P. guttata* and *P. paraguttata* in the pigmentation of the fore wing. *P. hellyeri* differs from these two species in lacking distinct postclypeal striae converging towards a pale midline, in the shape of both the apical spine on the dorsal valve and the external valve of the gonapophyses, and in possessing a sclerotised basal portion on the spermathecal duct.

Etymology. Named for Henry Hellyer, an early surveyor and explorer in Tasmania.

Philotarsopsis paraguttata (Thornton and New)

Haplophallus paraguttata Thornton and New, 1977: 8.

Latrobiella paraguttata. --- Thornton, 1981: 433.

Philotarsopsis paraguttata. --- Lienhard and Smithers, 2002: 336.

Material examined. Many individuals collected from February to June.

Distribution. Tasmania, Victoria, New South Wales and Queensland.

Remarks. This locally widespread species was collected in similar habitats to *P. guttata*.

Elipsocidae

Key to Tasmanian genera of Elipsocidae

1. Tarsi two-segmented 2
 - Tarsi three-segmented 3
2. Macropterous or micropterous
 - *Villopsocus* Schmidt and New
 - Apterous *Paedomorpha* Smithers
3. Ventral valve of gonapophyses very short (males unknown)
 - *Paedomorpha* Smithers
 - Ventral valve of gonapophyses long and slender (males known) 4
4. Small pores in female fore wings; dorsal valve spine longer than apex of lobe; hypandrium margin round
 - *Gondwanapsocus* Schmidt and New
 - Female fore wings without pores; apex of dorsal valve lobe and spine about equal in length; hypandrium margin transverse or laterally lobed 5
5. Fore wing with single rank of setae on basal veins, pulvillus broad 6
 - Fore wing with two ranks of setae on basal veins, pulvillus narrow 7
6. Macropterous, fore wing vein *m* five-branched
 - *Pentacladus* Enderlein
 - Macropterous, brachypterous or micropterous, fore wing vein *m* three-branched *Propsocus* McLachlan
7. Antenna segments with white apices; clypeal shelf narrow; eyes small and round
 - *Diademadrilus* Schmidt and New
 - Antenna segments uniformly pigmented; clypeal shelf broad; eyes large and ovoid 8
8. Subgenital plate lacking apical setae; aedeagal arch of phallosome with apical “clawed” projections
 - *Onychophallus* Schmidt and New
 - Subgenital plate with pair of apical setae; apex of aedeagal arch of phallosome lacking “clawed” projections
 - *Telmopsocus* Schmidt and New

Diademadrilus Schmidt and New

Diademadrilus Schmidt and New, 2004a: 164. Type species: *Spilopsocus annulatus* Smithers.

Diademadrilus masseyi (New)

Spilopsocus masseyi New, 1971: 226.

Diademadrilus masseyi. --- Schmidt and New, 2004a: 164.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and South Australia.

Remarks. This species is restricted to coastal sites in northern, northwestern and northeastern Tasmania. On the east coast it is found as far south as Freycinet National Park. It was taken only in dry coastal scrub and heath.

Gondwanapsocus Schmidt and New

Gondwanapsocus Schmidt and New, 2004a: 166. Type species: *Gondwanapsocus australis* Schmidt and New.

Gondwanapsocus australis Schmidt and New

Gondwanapsocus australis Schmidt and New, 2004a: 167.

Material examined. Site 353, 1♂, 21 Mar 88; site 356, 2♂, 18 Mar 88; site 364A, 1♂, 15 Feb 88; site 364B, 1♂, 15 Feb 88; site 364C, 1♂, 15 Feb 88; site 365B, 1♂, 15 Feb 88; site 366B, 2♂, 16 Feb 88.

Distribution. Tasmania.

Remarks. Confined to coastal vegetation on the southern coast of Tasmania.

Onychophallus Schmidt and New

Onychophallus Schmidt and New, 2004a: 167. Type species: *Onychophallus diemenensis*.

Onychophallus diemenensis Schmidt and New

Onychophallus diemenensis Schmidt and New, 2004a: 169.

Material examined. Many individuals collected from October to February.

Distribution. Tasmania.

Remarks. Most common on *Nothofagus* and rainforest conifers this early summer species was taken in October as nymphs only. At the type locality (site 75A) adults were taken only in November (site not sampled in December) but nymphs, presumed to be of this species, were collected from July to October. By January at this site adults were not found but again nymphs, this time presumably of *Telmopsocus*, were taken.

Paedomorpha Smithers

Paedomorpha Smithers, 1963: 32. Type species: *Paedomorpha gayi* Smithers.

Paedomorpha gayi Smithers

Paedomorpha gayi Smithers, 1963: 32.

Material examined. Queens Domain, Hobart, loose bark on eucalypt, 11♀, 17 April 1968 (V. V. Hickman).

Distribution. Tasmania, Victoria, New South Wales, Western Australia and New Zealand.

Remarks. This species has been recorded previously from this locality in Tasmania. Although Queens Domain was sampled on several occasions no additional material was collected during this study.

Pentacladus Enderlein

Pentacladus Enderlein, 1906: 408. Type species: *Pentacladus eucalypti* Enderlein.

Pentacladus eucalypti Enderlein

Pentacladus eucalypti Enderlein, 1906: 408.
!*Pentacladus eucalypti*. --- Cole et al., 1989: 34.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Victoria, New South Wales, Queensland, South Australia and New Zealand.

Remarks. *P. eucalypti* was found from September to May, but dead *Eucalyptus* foliage was not sampled from June to August. The species has been collected previously in May, June, August and September (Edwards, 1950) in Tasmania, and therefore appears to be present all year. It is locally widespread and known from both dry and wet forests. Closer examination of the Flinders I (Bass Strait) material of this species reveals marked differences in the shape of the apex of the aedeagal arch of the phallosome. The size, coloration and details of female genitalia are similar to those of *P. eucalypti*. The material represents a new undescribed species of *Pentacladus*.

Propsocus McLachlan

Propsocus McLachlan, 1866: 352. Type species: *Psocus pallipes* McLachlan.

Key to Tasmanian species of Propsocus

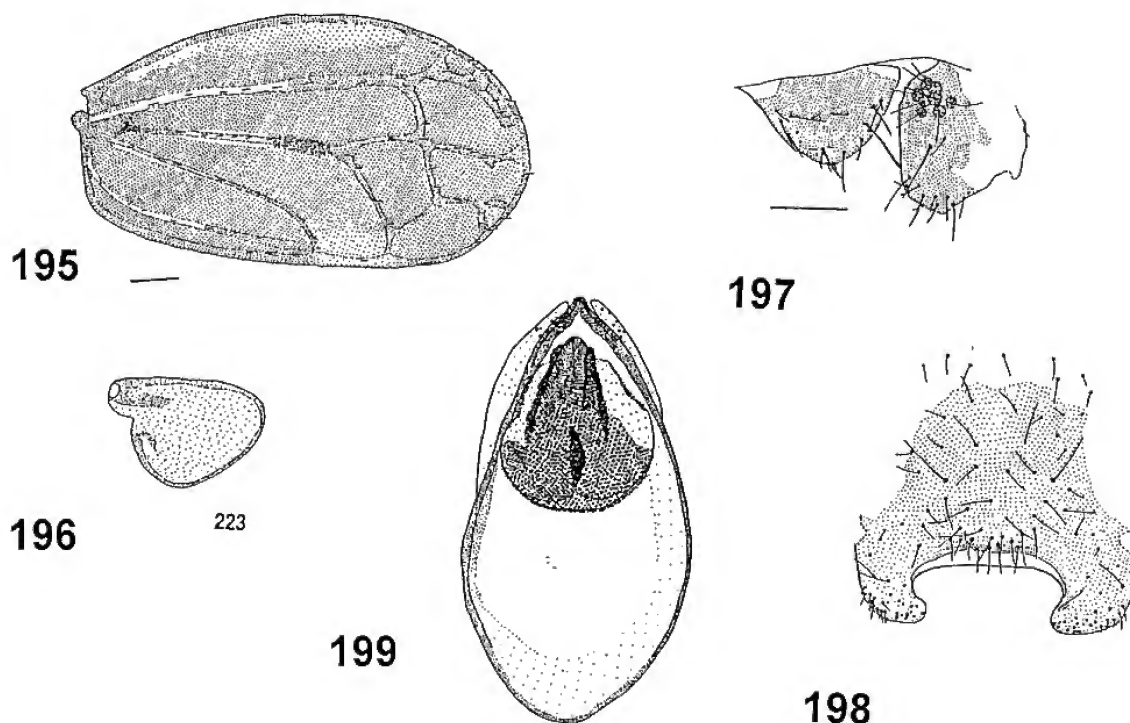
1. Hypandrium with transverse margin (gonapophyses with broad, well developed membranous break between inner sclerotised margin of dorsal valve and external valve) *pallipes* McLachlan
- Hypandrium with lateral lobes 2
2. Aedeagus of phallosome with mucronate apex (gonapophyses with narrow, somewhat incipient membranous break between inner sclerotised margin of dorsal valve and external valve) *pulchripennis* (Perkins)
- Aedeagus of phallosome lacking mucronate apex (females unknown) *frodshami* sp. nov.

Propsocus frodshami sp. nov.

Figures 195–99

Material examined. Holotype♂: Tasmania, Central Plateau, near Projection Bluff, 1200 m, 41°44'S 146°42'E, Suction, 27 April 1988 (L. Hill). Additional record: 1♂, Mt William National Park, sedge, 11 July 1986.

Description of male. *Coloration* (after ca 5 years in alcohol). Vertex brown, with dark brown elongated spots on each side of median epicranial suture, along back of vertex and dorsal to eyes, these fusing into band extending anteriorly around eye and merging with dark brown gena. Ocelli pale, brown ocellar region with narrow dark brown surround. Narrow band along lateral epicranial suture dark brown. Frons brown, with dark brown median stirrup mark. Epistomal suture dark brown.



Figures 195-199. *Propsocus frodshami*. Male: 195, fore wing; 196, hind wing; 197, epiproct and paraproct; 198, hypandrium; 199, phallosome. Figures 195, 196 and 197-199 to common scales.

Postclypeal striae dark brown, merging at midline, striae originating short distance anteriorly of epistomal suture, leaving narrow brown posterior postclypeal margin. Anteclypeus pale. Labrum dark brown. Maxillary palpi brown. Scape, pedicel and basal flagellar segment of antenna pale brown, remaining segments brown. Eyes black. Fore wing (fig. 195) brown, basal veins hyaline over most of their length. Hind wing (fig. 196) with brown tinge. Prothorax pale, meso- and meta-thorax dark brown. Legs: procoxa pale, meso- and metacoxa dark brown; femora, tibiae and basal tarsus pale, mid and apical tarsal segments brown. Abdomen pale brown, terminal segments brown.

Morphology. IO:D = 3.0. Distal margin of labrum bearing 11 sensilla, anterior margin of outer surface with distinct row of 4 sensilla. Lacinia usual for genus, outer tine larger than median. Epistomal suture present, clypeal shelf broad. Head and thorax glossy. Frons tall. Majority of setae clothing head lost in preparation. Sockets on vertex and frons fairly sparse, those of postclypeus smaller and slightly denser. Setae on gena short and fine. Surface of head finely granular. Stirrup-mark on frons consisting of large polygonal cells, not granulated. Apex of terminal segment incipiently mucronate. Distribution of placoid sensilla: 2 base f_1 , 1 apices f_4 , f_6 and f_{10} ; those of f_6 and f_{10} each

bearing a short slender filament. Brachypterous. Fore wing (fig. 195): veins bearing single rank of setae; vein cu_2 setose; setae of single rank on inner margin of costa around apical margin. Hind wing (fig. 196) rudimentary, lacking setae. Marginal scales of wings of low relief, bluntly pointed at distal ends. Tarsi 3-segmented, claw with incipient subapical tooth, pulvillus broad. Rasp and mirror of Pearman's organ well developed. Epiproct (fig. 197) semicircular, setose. Paraproct (fig. 197) with field of 8/9 trichobothria. Hypandrium (fig. 198) lateral lobes apically medially directed, apices bearing very short setae. Phallosome (fig. 199): frame broad; sclerotised arms of aedeagal arch short, bearing small tubercles; endophallus similar to that of *Pentacladus eucalypti* Enderlein.

Dimensions. B 2.2, FW 0.96, HW 0.24, F 0.66, T 1.09, t_1 0.332, t_2 0.079, t_3 0.095, rt 4.2:1:1.2, ct 7.0:0, f_1 0.569, f_2 0.521.

Female. Unknown.

Remarks. In possessing a bilobed hypandrium and a phallosome apex bearing small tubercles this species resembles *P. pulchripennis*. The apex of the aedeagal arch of *P. pulchripennis* is mucronate with small tubercles, differing from that of *P. frodshami*, which has a small transverse apex with small tubercles extending anteriorly along the arms of the inner

parameres. The form of the endophallus also differs between the two species. *P. frodshami* is larger than *P. pulchripennis*.

Etymology. Named for Thomas Frodsham, an early surveyor and explorer in Tasmania.

Proposocus pallipes (McLachlan)

Psocus pallipes McLachlan, 1866: 349.

Proposocus pallipes. --- McLachlan, 1866: 352.

Material examined. **Site** 66, 1♀, 2♂, 4 Sep 86; 3♀, 30 Oct 86; **site** 74, 1♂, 18 Mar 87; **site** 98, 2♀, 1♂, 1 nymph, 11 Sep 86; **site** 99, 9♀, 19♂, 2 nymphs, 10 Oct 86.

Distribution. All Australian states including Victoria (unpublished) except Northern Territory.

Remarks. This species was found mainly on dead *Eucalyptus* foliage only in dry forests. Additional collecting is required to determine the phenology of this species.

Proposocus pulchripennis (Perkins)

Stenopsocus pulchripennis Perkins, 1899: 83.

Proposocus pulchripennis. --- Zimmerman, 1957: 179.

Material examined. **Site** 16A, 2♀, 1♂, 26 Feb 87; **site** 87, 1♂, 16 Jan 87; **site** 104, 1♀, 22 Mar 87; 1♂, 21 Apr 87; **site** 107, 1♀, 1♂, 4 Feb 87; 7♀, 5♂, 22 Mar 87; **site** 139, 1♂, 18 Jan 87; **site** 185, 1♀, 22 July 86; **site** 200A, 1♀, 18 Apr 87; **site** 200B, 1♂, 18 Apr 87; **site** 268, 1♀, 1 nymph, 28 Feb 88.

Distribution. Cosmopolitan.

Remarks. This species was taken from several sites but not from dead *Eucalyptus* foliage. Apart from a single individual in July this species was found only from January to April.

Telmopsocus Schmidt and New

Telmopsocus Schmidt and New, 2004a: 174. Type species:

Telmopsocus waldheimensis Schmidt and New.

Telmopsocus waldheimensis Schmidt and New

Telmopsocus waldheimensis Schmidt and New, 2004a: 174.

Material examined. Many individuals collected from February to July.

Distribution. Tasmania.

Remarks. As noted above under *Onychophallus*, nymphs of this species may have been taken in January at one site. It is more common than *Onychophallus* and occurs in many of the same sites, but is found in late summer and autumn.

Villopsocus Schmidt and New

Villopsocus Schmidt and Thornton, 2004a: 176. Type species:

Villopsocus tasmaniensis Schmidt and New.

Villopsocus tasmaniensis Schmidt and New

Villopsocus tasmaniensis Schmidt and New, 2004a: 177.

Distribution. Tasmania.

Remarks. Previously recorded from Tasmania (Schmidt and New, 2004a), this species was not found during this study.

Psocidae

Key to Tasmanian genera of Psocidae

1. Pterostigma of fore wing elongate, narrow *Tanystigma* Smithers
- Pterostigma of fore wing normal 2
2. Phallosome frame posteriorly open, dorsal valve of gonapophyses with rudimentary apical spine* *Blaste* Kolbe
- Phallosome frame closed, dorsal valve of gonapophyses with apical spine well developed 3
3. Phallosome with apical pair of double spines, subgenital plate lobe with lateral pair of pigmented bands *Clematostigma* Enderlein
- Phallosome lacking apical pair of double spines, subgenital plate lobe medially uniformly pigmented *Ptycta* Enderlein

* The apical spine on the dorsal valve of the gonapophyses of *Blaste lignicola* (Enderlein) is well developed.

Blaste Kolbe

Blaste Kolbe, 1883b: 79. Type species: *Blaste juvenilis* Kolbe.

Key to Tasmanian species of Blaste

1. Male epiproct with lateral anteriorly directed lobes, dorsal flap absent; subgenital plate with sinuous row of preapical setae *lignicola* (Enderlein)
- Male epiproct lacking anteriorly directed lobes, dorsal flap present; subgenital plate lacking row of preapical setae 2
2. Hypandrium lacking lateral “horns”; subgenital plate lobe short, apical margin emarginate *panops* Smithers
- Hypandrium with conspicuous lateral “horns”; subgenital plate lobe well developed, apical margin rounded or transverse 3
3. Hypandrium with median tongue and longitudinal ridges with apical group of spines; anterior pigmented arms of subgenital plate not divergent *taylori* New
- Hypandrium with rounded median apex; anterior pigmented arms of subgenital plate divergent 4
4. Fore wing with apical brown bands *bistriata* Schmidt and Thornton
- Fore wing lacking strong apical pattern 5

5. Fore wing cell *An* basally with brown pigment *falcifer* Smithers
 — Fore wing cell *An* basally lacking brown pigment *tillyardi* Smithers

Blaste bistrata Schmidt and Thornton

Blaste bistriata Schmidt and Thornton, 1993: 192.

Material examined. Tasmania: 1♀, under stones, Ferntree, 28 May 1957 (V. V. Hickman); 1♀, 1♂, 1nymph, under stones, Ferntree, 28 May 1957 (V. V. Hickman); 1♂, Arve Loop, mixed forest, 31 Mar 1987; 1♂, Gladstone–Bridport Road, heath, 12 May 1987.

Distribution. Tasmania, Victoria and New South Wales.

Blaste falcifer Smithers

Figures 200–05

Blaste falcifer Smithers, 1979: 66.

This species was described from a single male collected from southwestern Tasmania. Additional material of both sexes was obtained in this study and a description of the female is provided.

Material examined. Specimen on which description based: Tasmania, 1♀, Cradle Mountain – Lake St Clair National Park, *Athrotaxis selaginoides*, Weindorfers Forest, 7 Feb 1987. Additional records: many individuals collected from January to May.

Description of female. Coloration (after ca 5 years in alcohol). Identical to that of male, including fore wing (fig. 200) pattern.

Morphology. IO:D = 2.3 (IO:D = 1.8 for male). Head larger than male. Antennae long, very slender, with sparse fine setae; sensory placoids: 3 base f_1 , 1 apices f_4 , f_6 and 1 central f_1 ; terminal segment bluntly rounded. Fore wing (fig. 200) with setae on posterior and anterior margins of veins r , $m+cu$ and an ; vein cu_2 with few fine setae; veins rs and m fused for a short length; both sections of vein cu_{1a} at slight angle, basal section longer than apical section. Hind wing (fig. 201) glabrous. Epiproct (fig. 202) with pair of weakly sclerotised lateral longitudinal bars. Paraproct (fig. 202) with round field of 35 trichobothria. Subgenital plate (fig. 203) with apically setose rectangular median lobe. Gonapophyses (fig. 204): ventral valve with slender apical spiculate spine; dorsal valve with broad blunt spiculate apex; external valve transverse with large dorsal lobe. Spermathecal plate (fig. 205).

Dimensions. B 3.6, FW 4.66, HW 3.45, F 0.96, T 2.01, t_1 0.624, t_2 0.197, rt 3.2:1, ct 27.3, f_1 0.774, f_2 0.711.

Remarks. This locally widespread species was taken from some sites of rainforest, wet scrub and heath. In general morphology and fore wing pigmentation this species is nearly identical to that of *B. panops*. However, both sexes of the two species can easily be separated on genitalic characters: the hypandrium of males of *B. falcifer* has a pair of well developed, curved posterolateral processes which are lacking in *B. panops*; the strong median lobe of the female subgenital plate of *B. falcifer* contrasts with the very short and medially emarginate lobe of *B. panops*. The female genitalia of *B. falcifer* resemble those of *B. bistriata* (above) and *B. tillyardi* (below), but all

can be separated on details of fore wing pigmentation. Specimens have been found to vary considerably in size. Fore wing lengths varied from 4.4–5.4 mm (♂), 4.0–4.7 mm (♀).

Blaste lignicola (Enderlein)

Psocus lignicola Enderlein, 1906: 401.

Euclismia lignicola. --- Enderlein, 1925: 100.

Blaste (Euclismia) lignicola. --- Badonnel, 1955: 253.

Euclismia lignicola. --- New, 1971: 228.

Blaste lignicola. --- Schmidt and Thornton, 1993: 195.

Material examined. Many individuals collected from January to June.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and Norfolk I.

Remarks. This species was found in dry coastal scrub and heath, and dry forest along the eastern, northern and northwestern coastline.

Blaste panops Smithers

Blaste panops Smithers, 1979: 63.

Distribution. Tasmania. This species was described from two individuals from south west Tasmania. No placename was cited for the type locality, which was designated by the co-ordinates 42°55'S 143°53'E.

Remarks. Smithers (1979) noted the similarities and differences of this species (described from singletons of each sex) to that of *Blaste falcifer* (see comments under that species above). This collection contains no additional material which is referable to this species.

Blaste taylori New

Blaste taylori New, 1974b: 286.

Material examined. Many individuals collected from February to June.

Distribution. Tasmania, Bass Strait Is, Victoria, New South Wales and Western Australia.

Remarks. This locally widespread species was collected from many sites of rainforest, mixed forest, dry coastal scrub and heath, and wet scrub.

Blaste tillyardi Smithers

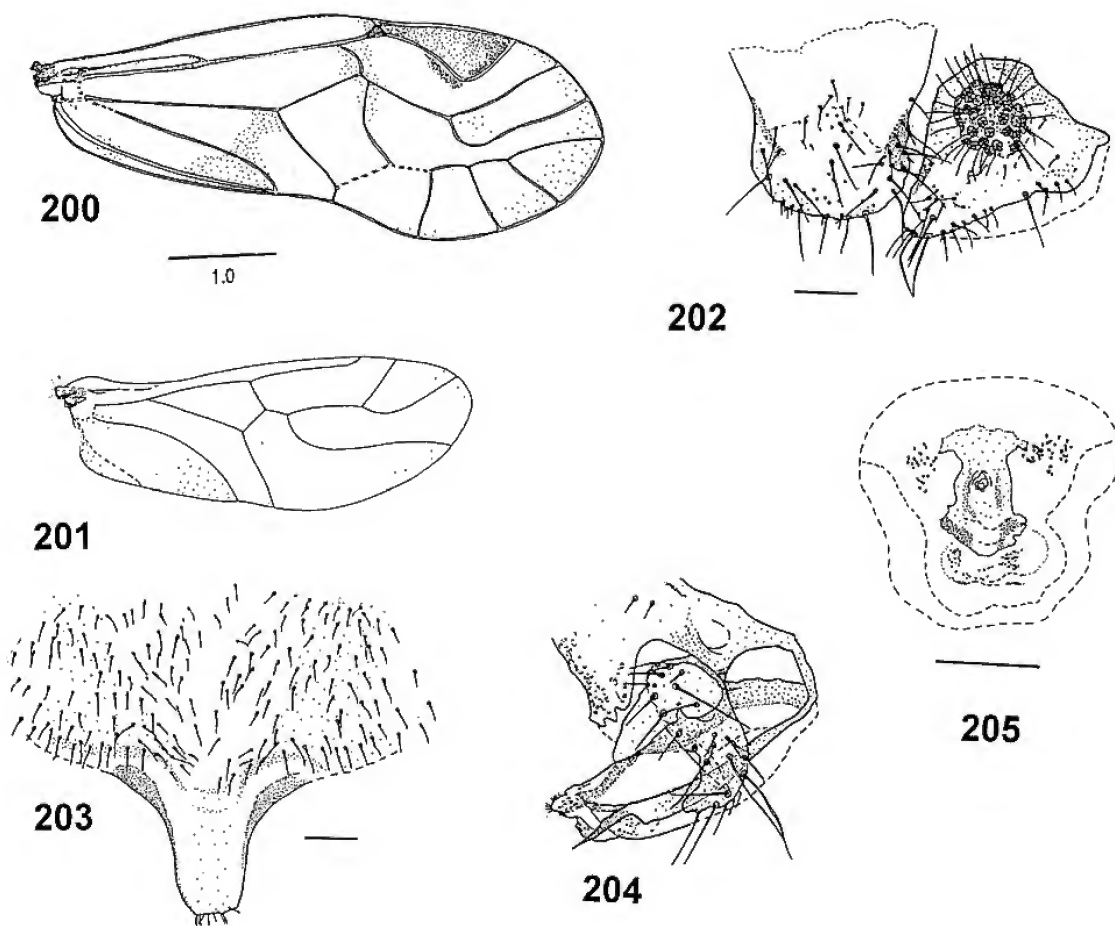
Blaste tillyardi Smithers, 1969: 338.

Material examined. **Site** 104, 1♀, 11 May 87; **site** 303, 1♀, 1♂, 28 Mar 87.

Distribution. Tasmania, Victoria, New South Wales and New Zealand.

Clematostigma Enderlein

Clematostigma Enderlein, 1906: 403. Type species: *Copostigma maculiceps* Enderlein.



Figures 200-205. *Blaste falcifer*. Female: 200, fore wing; 201, hind wing; 202, epiproct and paraproct; 203, subgenital plate; 204, gonapophyses; 205, spermathecal plate. Figures 200, 201 and 202 and 204 to common scales.

Clematostigma maculiceps (Enderlein)

Copostigma maculiceps Enderlein, 1903: 231.

Clematostigma maculiceps. --- Enderlein, 1906: 403.

Material examined. **Site** 115B, 1♀, 1♂, 22 Feb 88; **site** 152A, 1♀, 4♂, 10 nymphs, 23 Feb 88; **site** 175, 1♀, 26 Apr 87; **site** 177, 2♀, 3♂, 10 nymphs, 18 Mar 87; 1♀, 26 Apr 87; **site** 179A, 2♀, 10♂, 18 Mar 87; **site** 180A, 1♂, 18 Mar 87; **site** 200A, 1♀, 2♂, 8 nymphs, 18 Apr 87; **site** 200C, 8 nymphs, 18 Apr 87; **site** 207, 1♀, 17 Apr 87; **site** 248A, 11♀, 8♂, 24 Jan 87.

Distribution. Tasmania, Flinders I (Bass Strait), Victoria and New South Wales.

Remarks. This species was collected from January to April on the northern plains and slopes predominantly from wet forest. It was also taken at two coastal localities (Eddystone Point and Sisters Beach) from *Casuarina stricta* and *Banksia serrata*.

Ptycta Enderlein

Ptycta Enderlein, 1925: 102. Type species: *Psocus haleakalae* Perkins.

1. Hypandrium with asymmetrical tongue, ventral valve of gonapophyses long and slender 2
- Hypandrium lobes symmetrical, ventral valve of gonapophyses short 6
2. Antedorsum and dorsa of mesothorax dark brown *colei* sp. nov.
- Antedorsum and dorsa of mesothorax pale 3
3. ♀ IO:D = 3.0, ♂ IO:D = 2.2 *australis* Schmidt and Thornton

- ♀ IO:D = 2.0–2.4, ♂ IO:D = 1.3–1.5 4
- 4. Head with brown and mauve markings
..... *freycineti* sp. nov.
- Head with brown markings 5
- 5. Pterostigma of fore wing pigmented in apical third, not
extending basally past apex where spur-vein originates
..... *glossoptera* New
- Pterostigma of fore wing pigmented in apical half,
extending basally past apex where spur-vein originates
..... *pallawahensis* sp. nov.
- 6. Fore wing hyaline (except pterostigma), male paraproct
with rugose basal region *emarginata* New
- Fore wing with brown patches (except pterostigma), male
paraproct lacking rugose basal region 7
- 7. Phallosome incompletely closed; epiproct with narrow
elongated anterior projection; female fore wing with
brown band medially in cell Cu_2 *umbrata* New
- Phallosome completely closed; epiproct with broad semi-
circular anterior projection; female fore wing lacking
brown band medially in cell Cu_2
..... *campbelli* Schmidt and Thornton

***Ptycta australis* Schmidt and Thornton**

Ptycta australis Schmidt and Thornton, 1993: 201.

Ptycta glossoptera New. Cole et al., 1989: 34.

Ptycta sp. A. Cole et al., 1989: 34.

Material examined. Many individuals collected from November to August.

Distribution. Tasmania, Bass Strait Is and Victoria.

Remarks. Examination of the Bass Strait material (Cole et al., 1989) shows that records of *Ptycta glossoptera* New (males only) and *Ptycta* sp. A (females only) are of this species. The IO:D measured for males of this species by Schmidt and Thornton (1993) is incorrect; the correct value appears in the above key.

This species was found in wet scrub and heath in western, northwestern and northern regions, but on the northern coast it was taken on drier coastal scrub and heath. It was not found on the east coast south of Eddystone Point.

***Ptycta campbelli* Schmidt and Thornton**

Ptycta campbelli Schmidt and Thornton, 1993: 205.

Ptycta sp. C. Cole et al., 1989: 34.

Ptycta sp. C. G. Endersby et al., 1990: 219.

Material examined. Many individuals collected throughout the year.

Distribution. Tasmania, Bass Strait Is, Victoria and New South Wales.

Remarks. This species is the most locally widespread and common of the Psocidae in Tasmania. It appears to have little habitat specificity.

***Ptycta colei* sp. nov.**

Figures 206–13

Ptycta hollowayae Smithers. Cole et al., 1989: 34.

Material examined. Holotype ♂: Tasmania, UV light trap, open forest remnant, University of Tasmania, Hobart, 13 May 1986. Paratype ♂: same data as holotype; paratype ♀: *Bedfordia salicina*, montane grassy forest, Tunbridge-Steppes Road, 29 May 1986. Additional records: **site** 45, 1♂, 1 nymph, 5 June 87; **site** 127A, 1♀, 24 Mar 87; 1♂, 22 Feb 88; **site** 131E, 1♀, 2 nymphs, 24 Feb 88; **site** 159B, 1♂, 18 Jan 87; **site** 214A, 1♀, 2 Mar 87; 1♀, 17 Mar 87.

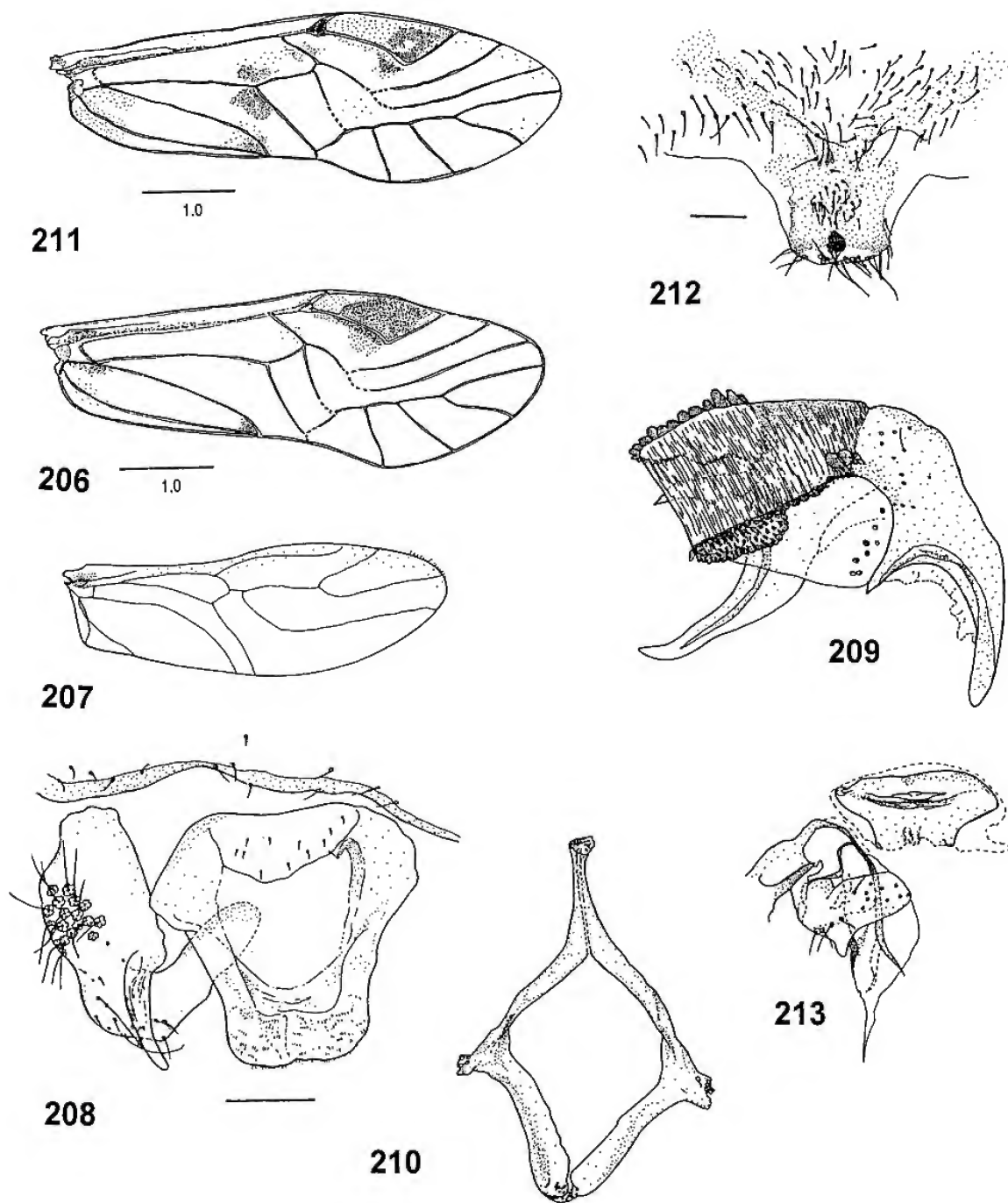
Description of male. *Coloration* (after ca 4.5 years in alcohol). Ground colour of head buff, with the following dark brown: markings along back of vertex, dorsal to eyes and along median epicranial suture; band along epicranial arm from ring surrounding antenna base to narrow band adjacent to lateral ocelli; stirrup mark centrally on frons; parallel striae on postclypeus; antenna; two apical segments of maxillary palp. Posterior third of anteclypeus and labrum brown. Eyes black. Ocelli pale, with black internal borders. Thorax dark brown, with paler sutural areas. Legs buff except coxa, apices of femur and tibia, tarsal segments dark brown. Fore wing (fig. 206). Hind wing (fig. 207) hyaline. Abdomen grey-brown dorsally, pale ventrally, terminal segments dark brown.

Morphology. IO:D = 1.2. Eyes large, offstanding, reaching well beyond vertex when viewed from side of head. Median epicranial suture distinct, ocelli on raised tubercle. Antennae long, finely setose, sensory placoids: 2 at base f_1 , 1 at apices f_2 , f_4 and f_{10} . Apex of terminal segment bluntly pointed. Fore wing (fig. 206): few fine setae on costa in region of pterostigma; veins sparsely setose, except cu_2 ; short fine setae on basal veins as follows: posterior margin of r , scattered on vein and margin of $m+cu$, on both posterior and anterior margins of an . Both sections of vein cu_{1a} at slight angle, approximately equal in length. Pterostigma lacking spur-vein, veins rs and m joined by a short cross-vein. Hind wing (fig. 207) glabrous, except for few short fine setae on margin between veins r_{2+3} and r_{4+5} . Epiproct (fig. 208, anterior margin facing posterior direction) margin well sclerotised, anterior margin bilobed, spiculate. Paraproct (fig. 208) with large terminal spine, round field of 38 trichobothria. Hypandrium (fig. 209) with strap-like tongue, bearing row of bluntly pointed teeth along margin, these becoming smaller, with more rounded apex towards distal end of tongue; apex of tongue asymmetrically curled. Phallosome (fig. 210) frame closed, with short central lateral projections and slender elongate apex.

Dimensions. B 3.8, FW 5.10, HW 3.86, F 0.99, T 2.15, t_1 0.576, t_2 0.197, rt 2.9:1, ct 27.4, f_1 1.181, f_2 0.941.

Description of female. *Coloration* (after ca 4.5 years in alcohol). As male, except dark brown band along epicranial arm and ring surrounding base of antenna not as distinct. Fore wing (fig. 211).

Morphology. IO:D = 1.8. Eyes offstanding. Antennae finely pubescent, sensory placoids: 4 at base f_1 , 1 at apices f_4 , f_6 and f_{10} . Fore (fig. 211) and hind wings as male. Epiproct setose in apical half, lateral margins sclerotised. Paraproct with round field of 38 trichobothria. Subgenital plate (fig. 212) with



Figures 206-213. *Ptycta colei*. Male: 206, fore wing; 207, hind wing; 208, epiproct and paraproct; 209, hypandrium; 210, phallosome. Figures 206, 207 and 208-210 to common scales. Female: 211, fore wing; 212, subgenital plate; 213, gonapophyses and spermathecal plate. Figures 212 and 213 to common scale.

small field of preapical setae on lobe, and longer setae on body of plate. Gonapophyses and spermathecal plate (fig. 213).

Dimensions. B 4.0, FW 5.16, HW 3.98, F 1.03, T 2.33, t_1 0.624, t_2 0.229, rt 2.7:1, ct 28.4, f_1 1.286, f_2 0.941.

Distribution. Tasmania and Bass Strait Is.

Remarks. This species is most similar to *P. hollowayae* Smithers. Females differ in details of fore wing pigmentation: a triangular pigmented area bound by veins *r* and *rs* of *P. hollowayae* is absent in *P. colei*; the basal third of cell *An* is lightly pigmented in *P. colei* which appears absent in *P. hollowayae*. The pterostigma of the fore wing of males of *P. hollowayae* is uniformly pigmented. In contrast only about the apical half is pigmented in *P. colei*. *Ptycta colei* also lacks the darker clouds in the basal half of cell R_1 and apices of cells R_1 and R_3 which are present in the males of *P. hollowayae* (Smithers, 1984; fig. 70). The sclerotised process basad of the trichobothrial field of the male paraproct (Smithers, 1984; fig. 72) of *P. hollowayae* is not distinct in *P. colei*, and the basal margin of the anterior lobe of the epiproct is much more bilobed in *P. colei* than that shown for *P. hollowayae* (Smithers, 1984; fig. 71). *Ptycta colei* is a larger species, fore wing lengths vary from 4.6–5.1 mm (♀), 5.1–5.4 mm (♂). In both sexes the junction of veins *rs* and *m* in the fore wing varies from a short cross-vein to a short fusion.

Etymology. Named for Peter Cole, whose studies of the Bass Strait Psocoptera form a foundation for knowledge of this genus in the region.

Ptycta emarginata New

Ptycta emarginata New, 1974b: 299.

Ptycta cornigera New, 1974b: 301. --- Smithers, 1997: 119.

Ptycta sp. M. Cole et al., 1989: 34.

Material examined. **Site** 90A, 1♂, 1♀, 20 Feb 88; **site** 90B, 5♀, 20 Feb 88; **site** 159A, 2♀, 2♂, 7 Dec 86; 1♂, 23 Mar 87; 1♀, 23 Feb 88; **site** 160, 2♀, 3♂, 23 Feb 88; **site** 252B, 1♀, 1 nymph, 29 Feb 88.

Distribution. Tasmania, Bass Strait Is, Victoria (unpublished), New South Wales and Western Australia.

Remarks. New (1974b) described both *P. emarginata* (single female) and *P. cornigera* (males only) from Western Australian material. Female specimens from Tasmania are considerably darker than the described specimen. Both sexes have a central stirrup mark on the frons, and the epicranial arm bears a broad brown band (less distinct in the female) which is not mentioned in either of the original descriptions. This species was taken only in dry coastal scrub and the heath understorey of *Banksia serrata*.

Ptycta freycineti sp. nov.

Figures 214–21

Material examined. Holotype ♂: Tasmania, Cape Tourville, *Leptospermum grandiflorum*, 11 June 1987. One nymph, 2♀ and 1♂ paratypes: same data as holotype. Additional records: many individuals collected throughout the year.

Description of male. **Coloration** (after ca 4.5 years in alcohol). Ground colour of head buff. The following are dark brown: markings on back of vertex, dorsal to eyes and along median epicranial suture; ring surrounding antennae base; central stirrup mark on frons; parallel striae on postclypeus, these becoming obsolete anteriorly except in midline; two apical segments of maxillary palp; antennae. The following are mauve: patch each side of median epicranial suture on top of vertex; band along epicranial arm from lateral ocelli to base of antenna; small patch adjacent to epistomal suture each side of stirrup mark on frons. Labrum and anteclypeus colourless. Eyes purple-black. Ocelli pale purple, internally bordered black. Antedorsum and dorsa of mesothorax with mauve tinge, except anterior margin of antedorsum, both posterior mesad patches and margin of mesothorax dorsa, which are dark brown. Dorsa of metathorax dark brown, pleura dark brown with pale sutural areas. Legs buff except: coxa of meso- and meta-thoracic legs dark brown, femur with basally narrow and apically broader brown bands, tibia merging brown basally and apically, tarsal segments brown. Fore wing with brown pigment (fig. 214). Hind wing (fig. 215) hyaline. Abdomen brown with mauve annulations, terminal segments dark brown.

Morphology. IO:D = 1.5. Eyes large, offstanding, reaching beyond level of vertex when looking from side of head. Median epicranial suture distinct. Ocelli on raised tubercle. Antenna (type incomplete) long, slender, pubescent; sensory placoids: 3 at base f_1 , 1 at apices f_4 , f_6 and f_{10} , terminal segment bluntly rounded (from another preparation). Fore wing (fig. 214) and hind wing (fig. 215) with fine setae, veins *rs* and *m* fused for a short length. Epiproct (fig. 216) margin well sclerotised, anterior lobe transverse, spiculate. Paraproct (fig. 216) with large terminal spine and round field of 28 trichobothria, small rounded sclerotised area basad of trichobothrial field. Hypandrium (fig. 217). Phallosome (fig. 218) frame closed, with long lateral anteriorly directed projections.

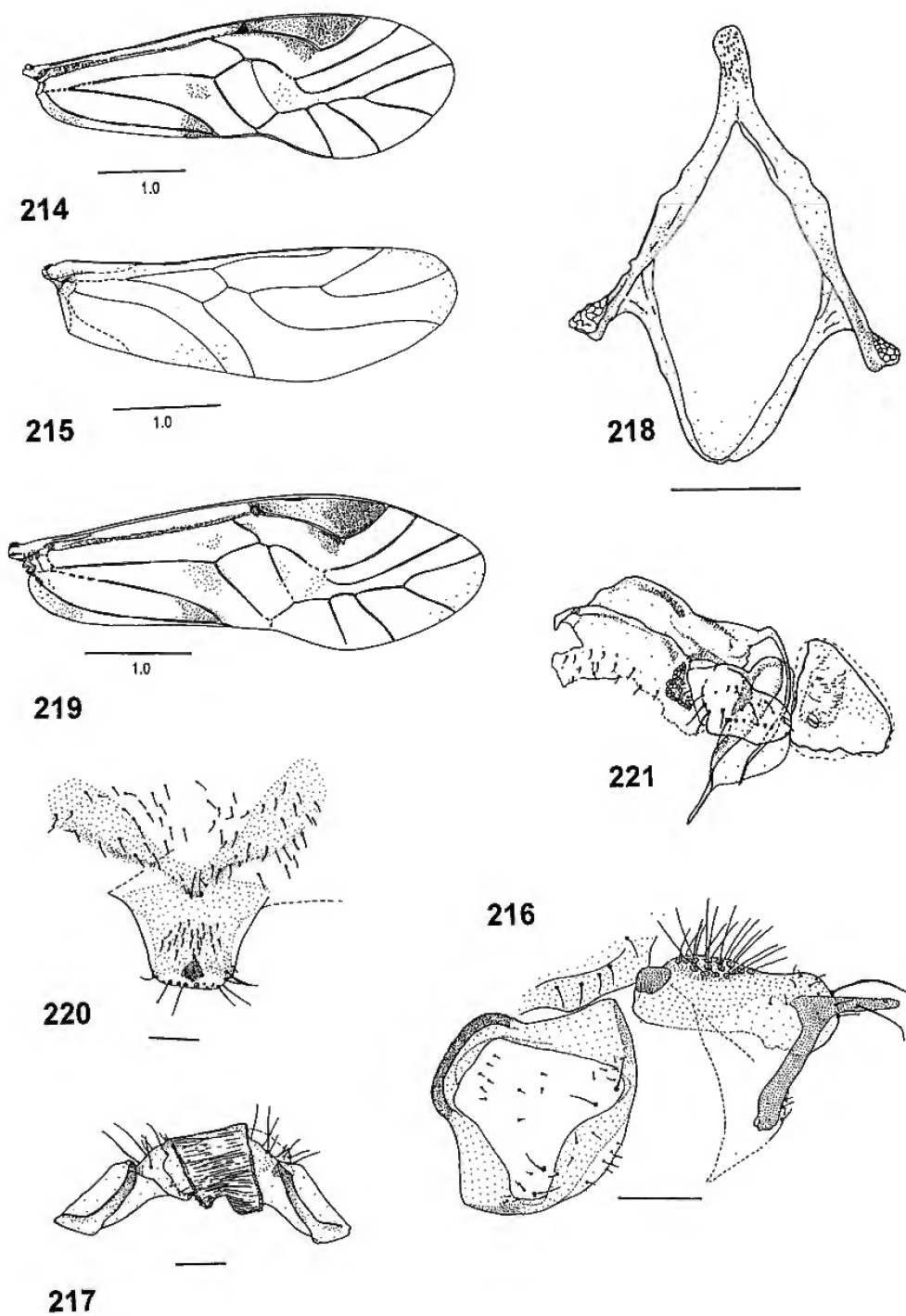
Dimensions. B 2.8, FW 4.45, HW 3.36, F 0.83, T 1.71, t_1 0.474, t_2 0.197, rt 2.5:1, ct 23.4, f_1 1.008, f_2 0.787.

Description of female. **Coloration** (after ca 4.5 years in alcohol). As male, with following exceptions: apical segment of maxillary palp brown, apex darker; basal flagellar segment of antennae brown, merging to dark brown apically, remaining segments dark brown. Fore wing (fig. 219).

Morphology. IO:D = 2.2. Eyes slightly offstanding. Median epicranial suture distinct. Antennal segments (incomplete) not as thick and less setose than male, sensory placoids: 3 at base f_1 , 1 at apices f_2 , f_4 , f_6 and f_{10} . Fore wing (fig. 219) as male except incipient spur-vein present from pterostigma. Epiproct setose in apical half, lateral margins sclerotised. Paraproct with round field of 26 trichobothria. Subgenital plate (fig. 220) median lobe apically setose, with small subapical triangular sclerotisation. Gonapophyses and spermathecal plate (fig. 221).

Dimensions. B 3.2, FW 3.92, HW 3.01, F 0.77, T 1.63, t_1 0.434, t_2 0.205, rt 2.2:1, ct 20.3, f_1 0.814, f_2 0.711.

Remarks. This species is closely related to *P. glossoptera*, *P. australis* and *P. pallawahensis* (below). It can be distinguished from the former two species in details of head pattern, as both



Figures 214-221. *Ptycta freycineti*. Male: 214, fore wing; 215, hind wing; 216, epiproct and paraproct; 217, hypandrium; 218, phallosome. Female: 219, fore wing; 220, subgenital plate; 221, gonapophyses and spermathecal plate. Figures 220 and 221 to common scale.

lack the mauve pigmentation found on *P. freycineti*. Differences from *P. pallawahensis* are noted in the comments following that species description (below). The development of the spur-vein from the pterostigma on the fore wing varies from small to absent (see comments on this character under the description of *P. glossoptera*, New 1974b). Wing length varies from 3.8–4.5 mm (♂), 4.2–4.5 mm (♀). Restricted to the peninsula in which Freycinet National Park forms a large part, this species was taken from only three dry coastal scrub habitats: *Hakea epiglottis*, *Kunzea ambigua* and *Leptospermum grandiflorum*.

Etymology. Named for Louis de Freycinet, a French navigator.

***Ptycta glossoptera* New**

Ptycta glossoptera New, 1974b: 302.

!*Ptycta glossoptera*. --- Cole et al., 1989: 34.

Material examined. Site 194B, 4♀, 17 June 87; 1♀, 27 July 87; site 261B, 1♂, 26 Mar 87; 1♀, 27 Apr 87; site 262A, 1♀, 1 nymph, 1 Mar 87; 1♀, 21 May 87; 1♀, 1 Mar 88; site 263, 6♀, 2♂, 25 Jan 87; 2♀, 2♂, 2 nymphs, 1 Mar 87; 1♀, 26 June 87; 5♀, 3 nymphs, 1 Mar 88.

Distribution. Tasmania, Victoria and South Australia.

Remarks. This species was taken in dry coastal scrub (particularly *Melaleuca ericifolia*) and heath. See comments below *P. australis* (above).

***Ptycta pallawahensis* sp. nov.**

Figures 222–30

Ptycta sp. H. Coy et al., 1993: 77.

Material examined. Holotype ♂: Tasmania, Daisy Dell, *Nothofagus cunninghamii*, 2 Mar 1987. Two nymphs, 1♂ and 3♀ paratypes: same data as holotype. Additional records: many individuals collected from January to May.

Description of male. *Coloration* (after ca 4.5 years in alcohol). Ground colour of head buff, with the following exceptions: patches on back of vertex, dorsal to eyes and along median epicranial suture; ring surrounding antennae base; central stirrup mark on frons; parallel striae on postclypeus, becoming obsolete anteriorly except at midline; two basal segments of maxillary palp; antenna. Eyes black. Ocelli pale, internally bordered black. Labrum and anteclypeus colourless. Antedorsum and anterior half of mesothoracic dorsa buff, remainder of thorax dark brown with pale sutural areas. Legs buff except coxa of meso- and meta-thoracic legs dark brown, femora with broad brown apical band, tibiae merging brown apically, tarsal segments dark brown. Fore wing pigmented (fig. 222). Hind wing hyaline (fig. 223). Abdomen grey-brown, terminal segments dark brown.

Morphology. IO:D = 1.3. General morphology similar to *Ptycta freycineti* (above) with following exceptions: antenna sensory placoids: 2 at base f_1 , 1 at apices f_2 , f_4 , f_6 and f_{10} ; small spur-vein from pterostigma. Epiproct (fig. 224). Paraproct (fig. 224) with sclerotised region basal to round field of 42 trichobothria. Hypandrium (fig. 225) with asymmetrical tongue, bearing row of bluntly pointed teeth along margin.

Phallosome (fig. 226).

Dimensions. B 3.3, FW 4.87, HW 3.75, F 0.92, T 1.96, t_1 0.569, t_2 0.221, rt 2.6:1, ct 25.5, f_1 0.979, f_2 0.826.

Description of female. *Coloration* (after ca 4.5 years in alcohol). As male, with the following exceptions: apical segment of maxillary palp brown, apex darker; scape, pedicel and three quarters of basal flagellar segment of antenna buff, apical quarter merging brown, remaining segments dark brown; tibia wholly buff. Fore wing (fig. 227).

Morphology. IO:D = 2.4. Postclypeal striae less distinct than in male. General morphology similar to *Ptycta freycineti* (above). Epiproct and paraproct (fig. 228), latter with round field of 29 trichobothria. Subgenital plate (fig. 229, torn at apex) lobe bearing row of long marginal setae, thickening of the internal membrane near posterior margin elongate. Gonapophyses (fig. 230): ventral valve slender; dorsal valve broad with long narrow process; external valve transverse, setose. Spermathecal plate (fig. 230).

Dimensions. B 3.9, FW 4.28, HW 3.36, F 0.86, T 1.75, t_1 0.474, t_2 0.205, rt 2.3:1, ct 23.3, f_1 0.798, f_2 0.648.

Remarks. This species is closely related to *P. australis*, *P. glossoptera* and *P. freycineti* (all above). The pterostigma of the fore wing of *P. glossoptera* is pigmented in the apical third, and basally does not extend beyond the apex where the spur-vein originates. *P. australis* is smaller than the other species, the males having very small eyes. Some specimens of *P. pallawahensis* have traces of the mauve pigmentation mentioned in the description of *P. freycineti*, however this is slight and lacking in the majority of specimens collected. The fascia of the fore wing is broader and more extensively pigmented in females of *P. pallawahensis*. The scape, pedicel and basal flagella segment of the antennae are buff in females of this species, compared to brown in *P. freycineti*. Males of *P. pallawahensis* are larger than those of *P. freycineti*. The extent of the spur-vein from the pterostigma on the fore wing varies in males, from small to absent; in females it appears always to be present. Wing length varies marginally, 4.3–4.5 mm (♀), 4.7–5.0 mm (♂). This widespread species was taken from *Nothofagus* and in wet scrub.

Etymology. In reference to *pallawah*, an indigenous term of self reference, and the former name of the type locality prior to it being named Daisy Dell.

***Ptycta umbrata* New**

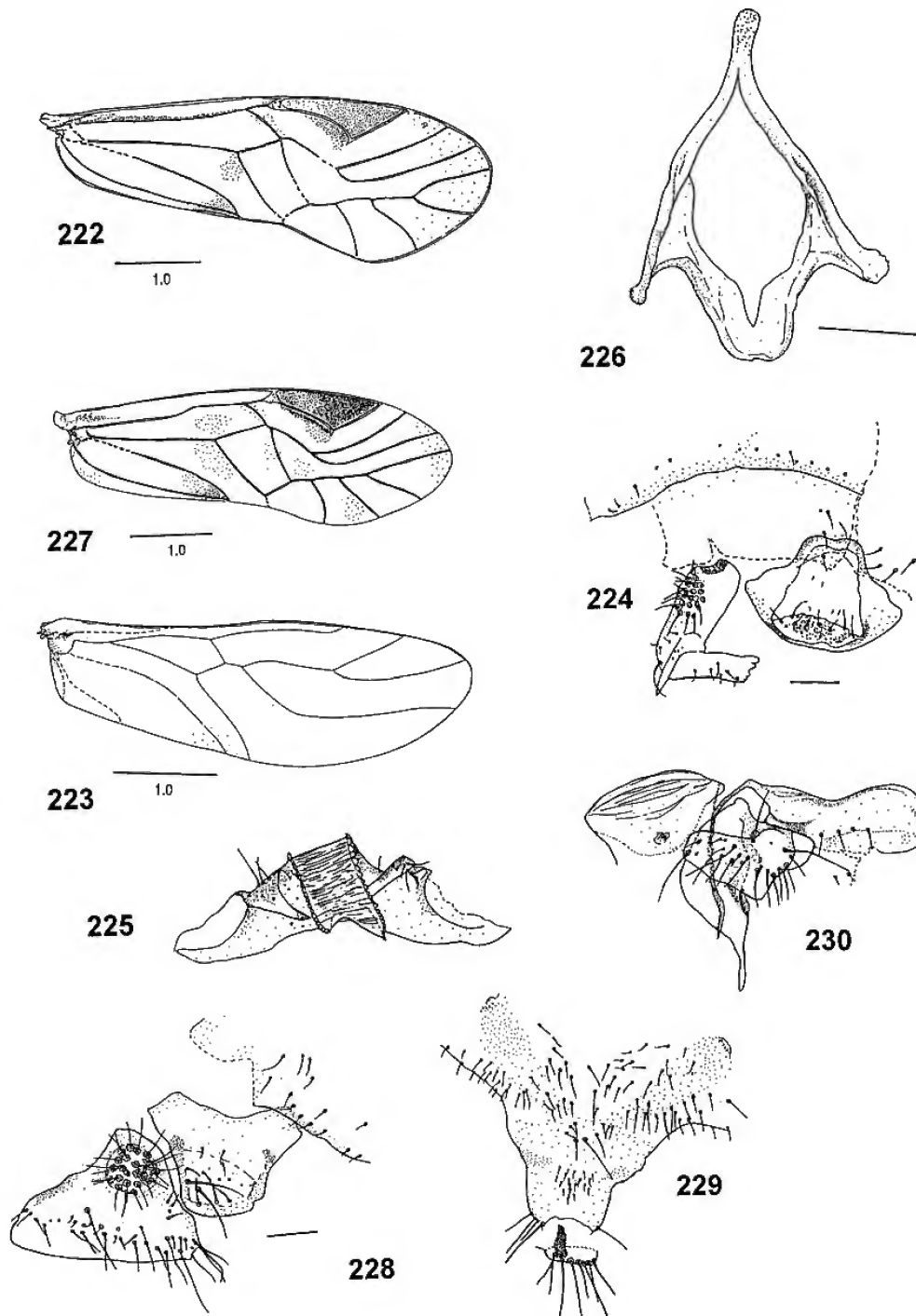
Ptycta umbrata New, 1974b: 297.

Material examined. St Helens Point, St Helens, *Casuarina littoralis*, 1♂, 24 Feb 1988.

Distribution. Tasmania, Victoria, New South Wales and South Australia.

***Tanystigma* Smithers**

Tanystigma Smithers, 1983: 77. Type species: *Copostigma (Clematostigma) paulum* Smithers.



Figures 222-230. *Ptycta pallawahensis*. Male: 222, fore wing; 223, hind wing; 224, epiproct and paraproct; 225, hypandrium; 226, phallosome. Figures 224 and 225 to common scale. Female: 227, fore wing; 228, epiproct and paraproct; 229, subgenital plate; 230, gonapophyses and spermathecal plate. Figures 228-230 to common scale.

Key to Tasmanian species of *Tanystigma*

1. Fore wing with both sections of vein cu_{1a} in straight line, phallosome with posterior pair of double spines **notiale group 2**
- Fore wing with both sections of vein cu_{1a} at distinct angle, phallosome with posterior pair of single spines **paulum group 3**
2. Hypandrium with apical pair of bulbous lobes; female epiproct apically emarginate; subgenital plate pigmented arms anteriorly divided *westae* sp. nov.
- Hypandrium apically with two short blunt spines; female epiproct apically transverse; subgenital plate pigmented arms anteriorly fused *maddeni* sp. nov.
3. Hypandrium apically bilobed, spermathecal plate triangular with pair of lateral sclerotised bars *edwardsi* New
- Hypandrium apically trilobed, spermathecal plate rounded 4
4. Distal segment of female maxillary palp distinctly darker at apex; two basal flagellar segments of female antenna pale brown; ♂ IO:D = 2.6 *inglewoodense* New
- Distal segment of female maxillary palp uniform dark brown; basal flagellar segment of female antenna pale brown; ♂ IO:D = 1.6 *tardipes* Edwards

Notiale Group

Diagnosis. Apical segment of antenna short, length about twice width. Fore wing with both sections of vein cu_{1a} in a straight line, and somewhat sinuous. Phallosome posteriorly with pair of double spines. A small apophysis extending posteriorly from ninth tergite adjacent to paraproct (not mentioned in the description of *notiale*). Lightly sclerotised setose dome between trichobothrial field and apical spur of paraproct of males absent.

Remarks. As noted by Schmidt and Thornton (1993) *Tanystigma* can be divided into two species groups based on the form of cu_{1a} in the fore wing and by the number of apical spines on the phallosome. Species of the *notiale* group include *T. notiale* (Smithers), *T. bifurcatum* Smithers, *T. dubium* (New) (males unknown), *T. valvula* Schmidt and Thornton, *T. maddeni* (below) and *T. westae* (below). No distinct genitalic characters appear to separate females into the two species groups.

***Tanystigma maddeni* sp. nov.**

Figures 231–39

Material examined. Holotype ♂: Tasmania, Freycinet National Park, *Casuarina stricta*, 17 Jan 1987. Eight nymphs and 6♀ paratypes: same data as holotype. Additional records: **site** 45, 2♀, 1♂, 5 June 87; **site** 52A, 1♀, 1 nymph, 7 June 87; **site** 88A, 1♀, 26 June 86; 1♀, 7 Aug 86; 6♀, 5♂, 8 nymphs, 21 Mar 87; 7♀, 3♂, 22 Apr 87; 3♀, 2♂, 11 May 87; 6♀, 2♂, 1 nymph, 20 Feb 88; **site** 95A, 1♀, 22 Apr 87.

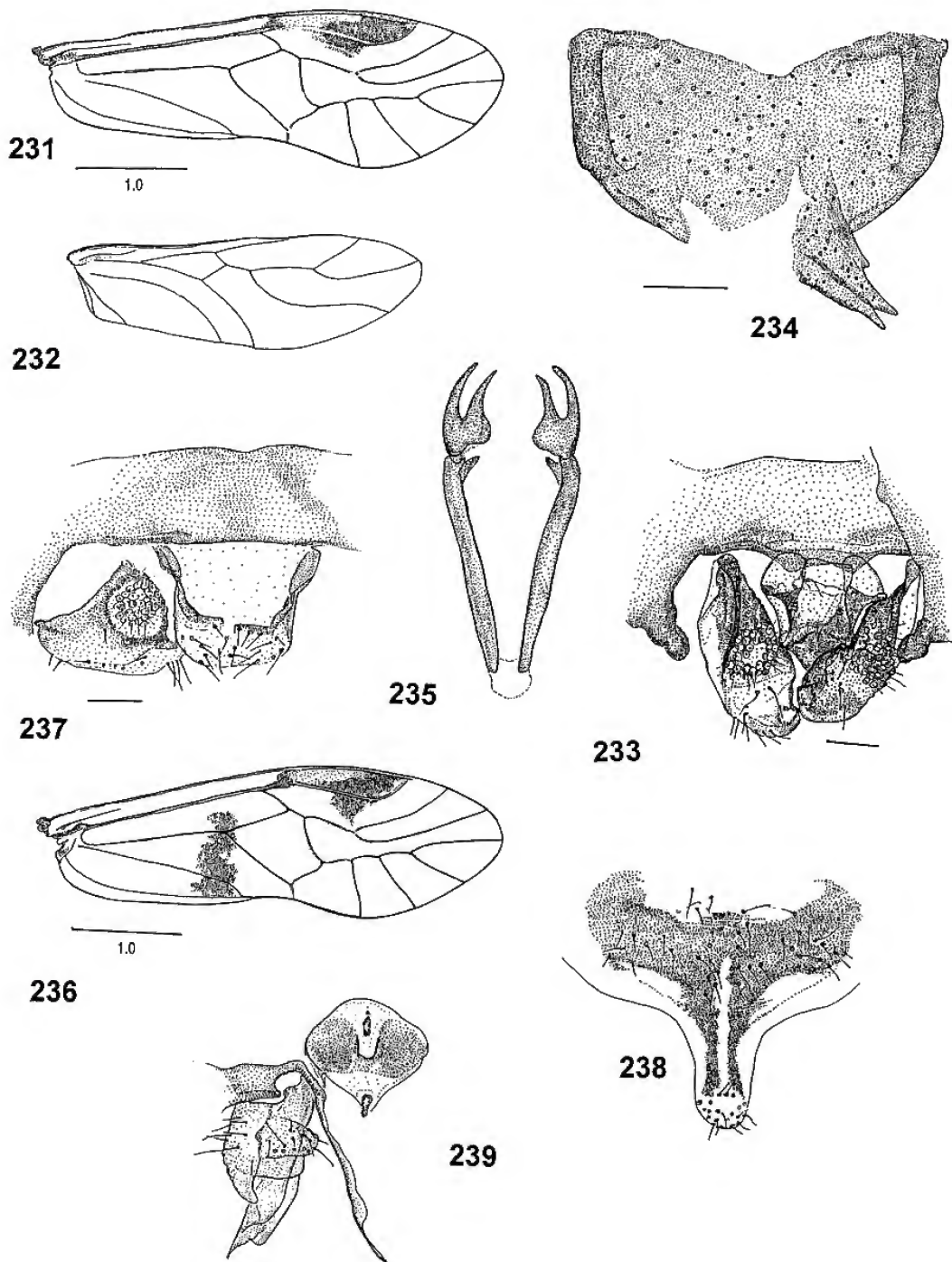
Description of male. Coloration (after ca 4 years in alcohol). Head buff with the following dark brown: patches dorsal to eyes, across back of vertex and along median epicranial suture, which is nearly black; band between eye and antennal socket; semicircular patch on frons ventral to anterior ocellus; epistomal suture and longitudinal parallel postclypeal striae; labrum and anteclypeus. Ocelli pale purple, interior borders black. Eyes purple-black. Antenna dark brown. Maxillary palps dark brown, apices of three basal segments buff. Fore wing (fig. 231) hyaline, veins dark brown. Hind wing (fig. 232) hyaline. Dorsa dark brown, scutella pale brown. Postnotum pale brown dorsally, dark brown ventrally. Pleura dark brown, sutural areas buff. Coxae and legs dark brown, trochanter buff. Abdomen with grey-brown longitudinal stripes, terminal segments dark brown.

Morphology. IO:D = 1.4. Eyes large, just below apex of vertex when viewed from side of head. Ocelli on raised tubercle. Antennae short (length 3.48mm), setose, f_{10} and f_{11} fused in terminal segment which narrows apically. Sensory placoids: 2 at base f_1 , 1 at apices f_4 , f_6 and f_{10} . Fore wing (fig. 231): very small scattered setae present on costa and vein of pterostigma, otherwise glabrous; first and second segments of cu_{1a} almost in straight line, and approximately equal in length; spur-vein not present. Hind wing (fig. 232) with few setae on margin between r_{2+3} and r_{4+5} . Epiproct (fig. 233) with small rectangular flap at base, each side of this a lightly sclerotised projection. Paraproct (fig. 233) with round field of 36 trichobothria, distinct curved sclerotised bar and an apical sclerotised spur. Posterior margin of ninth tergite with two rounded lobes where the epiproct articulates, larger lateral projections adjacent to paraprocts (fig. 233). Hypandrium (fig. 234) apically bifid, terminating in two short blunt spines. Phallosome (fig. 235) closed anteriorly, junction not sclerotised, posteriorly open with pair of double, sharp sclerotised spines.

Dimensions. B 2.8, FW 3.89, HW 2.95, F 0.69, T 1.54, t_1 0.411, t_2 0.190, rt 2.2:1, ct 22.0, f_1 0.798, f_2 0.656.

Description of female. Coloration (after ca 4 years in alcohol). As male, with following exceptions: stirrup mark on frons ventral to anterior ocellus; brown band extending from back of eye around ventral margin of eye; basal three segments of maxillary palp buff; ocelli buff. Fore wing (fig. 236) with complete transverse fascia.

Morphology. IO:D = 2.6. Antenna less setose than male, shorter (length 2.78mm). Terminal segment very small, apex rounded, sensory placoids: 2 at base f_1 , 1 at apices f_2 , f_4 , f_6 and f_{10} . Setae on fore wing (fig. 236) margin more extensive than male, basal section of cu_{1a} longer than apical section. Epiproct (fig. 237): sclerotised arms directed anteriorly; apical third with scattered setae. Paraproct (fig. 237) with round field of 27 trichobothria, apical margin setose. Subgenital plate (fig. 238) median lobe apically setose, few scattered setae near apical margin on lobe; pigment band fused anteriorly, laterally broad; two narrow arms extending posteriorly not reaching apical margin; scattered setae on plate. Gonapophyses (fig. 239): ventral and dorsal valves with narrow spiculate apices, external valve with large apical posterior lobe and a dorsal lobe. Spermathecal plate (fig. 239).



Figures 231-239. *Tanystigma maddeni*. Male: 231, fore wing; 232, hind wing; 233, ninth tergite, epiproct and paraproct; 234, hypandrium; 235, phallosome. Figures 231, 232 and 234 and 235 to common scales. Female: 236, fore wing; 237, epiproct and paraproct; 238, subgenital plate; 239, gonapophyses and spermathecal plate. Figures 237-239 to common scale.

Dimensions. B 3.2, FW 3.83, HW 2.83, F 0.67, T 1.44, t_1 0.363, t_2 0.197, rt 1.8:1, ct 14.0, f_1 0.711, f_2 0.498.

Remarks. This species is most similar to *T. valvula* found at Wilsons Promontory, Victoria, and *T. bifurcatum*, found in South Australia. All three species are similar in fore wing pigmentation, shape of the posterior apical lobe and smaller dorsal lobe of the external valve of the female gonapophyses, and the males possessing double-spined phallosomes. In female fore wing pigmentation *T. maddeni*, like *T. bifurcatum*, has a complete fascia, differing from the broken fascia of *T. valvula*. The anteriorly diverging pigmented arms of the subgenital plate are not fused medially in *T. bifurcatum* and *T. valvula* as they are in *T. maddeni*, and the small dorsal lobe of the external valve of the female gonapophyses is longer and more distinct in *T. maddeni* than in the other two species. The apically bifid hypandrium of *T. maddeni* is very similar to that of *T. valvula*, unlike the rounded median lobe of *T. bifurcatum*. The inner pair of spines on the phallosome is larger than the outer pair in *T. bifurcatum*, unlike *T. valvula*, in which the outer spines are larger, and *T. maddeni*, in which the spines are approximately equal in length. This species was collected from January to August mainly in dry coastal scrub from a few sites on the east coast.

Etymology. Named for Dr John Madden, in acknowledgement of his friendship, and his help to ERS during exploration in Tasmania.

Tanystigma westae sp. nov.

Figures 240–48

Material examined. Holotype ♂: Tasmania, Lyell Hwy, 20 kms east Derwent Bridge, *Hakea epiglottis*, 27 Aug 1991. Two ♀ and 2♂ paratypes: same data as holotype. Additional records: site 242 (holotype locality), 17 nymphs, 3 July 86; 14 nymphs, 12 Aug 86; 1 nymph 15 Sep 86; 1 nymph, 16 Oct 86.

Description of male. *Coloration* (after ca 3 months in alcohol). Ground colour of head light brown, with darker brown patches dorsal to eyes, across back of vertex and each side of median epicranial suture; broad brown band along arms of epicranial suture, merging with brown band between eye and dark brown ring of antennal socket; epistomal suture and longitudinal postclypeal stripes brown; ocellar protuberance dark brown, ocelli pale with black centripetal borders; large brown patch on frons below anterior ocellus; labrum and anteclypeus dark brown. Maxillary palp dark brown, apices of basal three segments pale. Antennae dark brown. Eyes black. Fore wing (fig. 240): hyaline, pigmentation of pterostigma dark brown; veins dark brown except: base of r_{2+3} and r_{4+5} ; cu_{1a} ; distal half of section of m between its leaving rs and joining cu_{1a} . Hind wing hyaline. Thorax: dorsa dark brown; postnotum light brown dorsally, dark brown ventrally; pleura dark brown, sutural areas pale. Coxae and legs dark brown. Abdomen pale brown with longitudinal brown stripes, one dorsally and two on each side. Terminal segments dark brown.

Morphology. IO:D = 2.5. Eyes small. Ocelli on slightly raised tubercle. Antenna: short (length 2.95mm), strongly setose; terminal segment small with narrow rounded apex; sensory placoids: 2 at base f_1 , 1 at apices f_4 and f_{10} . Fore wing

(fig. 240) glabrous, hind wing with few setae at margin between veins r_{2+3} and r_{4+5} . First and second sections of cu_{1a} almost in straight line, both sections approximately equal in length. Distal half of section of vein between its leaving rs and joining cu_{1a} strongly curved. Spur-vein present on pterostigma. Mesothoracic and metathoracic scutella well developed. Epiproct (fig. 241) sclerotised, fused to ninth tergite; a rounded basal median projection, each side of this a rounded setose lobe; posteriorly arrow shaped, a small central area containing three large setae and numerous smaller setae. Paraproct (fig. 241) with rounded field of 52 trichobothria, distinct curved sclerotised bar and an apical sclerotised spur. Ninth tergite with large lateral anvil-shaped projection adjacent to paraproct (fig. 241). Hypandrium (fig. 242): well sclerotised, symmetrical with apical pair of rounded bulbous lobes; at posterior lateral angle plate broadly folded anteriorly, adjacent to a longitudinal sclerotised bar at edge of plate; densely setose. Phallosome (fig. 243) posteriorly open with pair of double, sharp sclerotised spines.

Dimensions. B 3.9, FW 4.5, HW 3.4, F 0.79, T 1.75, t_1 0.474, t_2 0.205, rt 2.3:1, ct 18.3, f_1 0.830, f_2 0.600.

Description of female. *Coloration* (after ca 3 months in alcohol). As male with the following exceptions: brown band along ventral margin of eye; epicranial suture brown, arms lacking brown band; fore wing (fig. 244) with complete transverse fascia; hind wing (fig. 245) with areas of slight brown tinge; metathoracic scutellum dark brown.

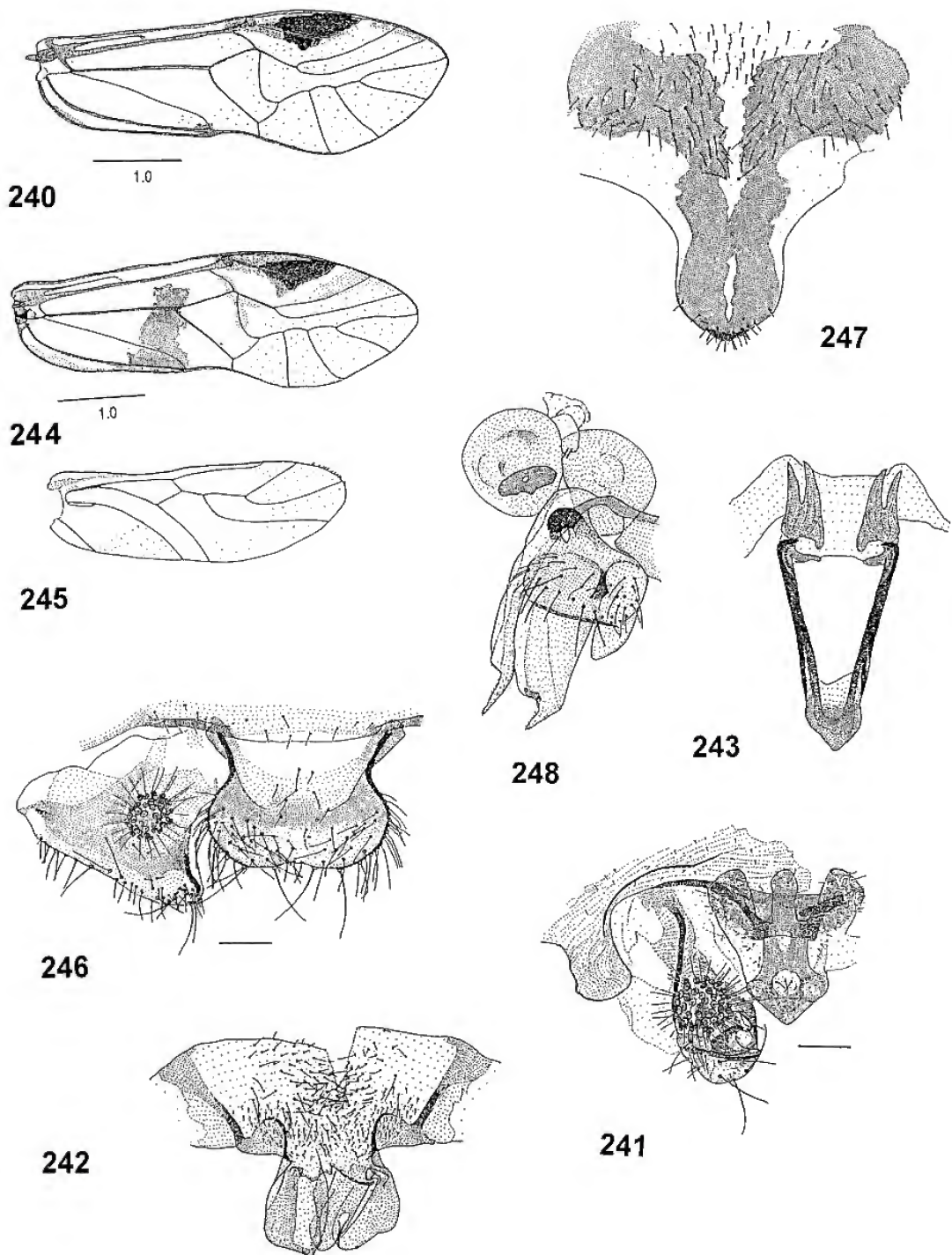
Morphology. IO:D = 3.6. Antenna: less setose than male, shorter (length 2.65mm); terminal segment very small, sensory placoids: 1 at base f_1 , 1 at apices f_2 , f_4 , f_6 and f_{10} . Epiproct (fig. 246): sclerotised arms directed anteriorly, incipiently bilobed posteriorly with two strong setae apically on each lobe; margin and body heavily setose. Paraproct (fig. 246): round field of 43 trichobothria; ventral surface rugose; apical margin setose. Subgenital plate (fig. 247): median lobe with small apical transverse sclerotised band, surrounding this numerous small setae; pigment band fusing apically, generally divided medially; scattered setae on plate with two larger setae posteriorly. Gonapophyses (fig. 248): ventral valve long, slender, apex narrow, spiculate; dorsal valve broad with narrow spiculate apex; external valve with small dorsal lobe, posterior edge of transverse lobe sclerotised, setose. Spermathecal plate (fig. 248) represented by two large round sclerotised areas.

Dimensions. B 4.2, FW 4.4, HW 3.3, F 0.75, T 1.61, t_1 0.363, t_2 0.198, rt 1.8:1, ct 15.0, f_1 0.670, f_2 0.510.

Remarks. Only nymphs of this species have been collected in the field. The holotype and paratypes were reared in the laboratory and were subsequently killed on 8 Sep 1991.

Males of *T. westae* differ from other species of this genus by the exaggerated size of the apophyses extending posteriorly from the ninth tergite adjacent to the paraprocts, the peculiar epiproct and shape of the hypandrium. Females differ markedly in the pigmentation of the subgenital plate, the bilobed epiproct and the sclerotisation of the spermathecal plate.

Etymology. Named for Dr Jan West, a friend and former fellow postgraduate student with ERS, who once attempted to collect this species while on a visit to Tasmania.



Figures 240-248. *Tanystigma westae*. Male: 240, fore wing; 241, ninth tergite, epiproct and paraproct; 242, hypandrium; 243, phallosome. Figures 241-243 to common scale. Female: 244, fore wing; 245, hind wing; 246, epiproct and paraproct; 247, subgenital plate; 248, gonapophyses and spermathecal plate. Figures 244, 245 and 246-248 to common scales.

Paulum Group

Diagnosis. Apical segment of antennae elongated, length about four times width. Fore wing with both sections of vein cu_{1a} at a distinct angle. Phallosome posteriorly with pair of single spines. The small apophysis extending posteriorly from ninth tergite adjacent to paraproct of males absent. Males with a lightly sclerotised setose dome between trichobothrial field and apical spur of paraproct.

Remarks. Species of the *paulum* group include *T. paulum* (Smithers), *T. latimentulum* (Smithers) (females unknown), *T. elongatum* Smithers, *T. longitibia* Smithers, *T. tardipes* (Edwards), *T. inglewoodense* (New), *T. edwardsi* (New) and *T. striatifrons* (McLachlan) (males unknown).

Tanystigma edwardsi (New)

Figures 249–53

Clematostigma edwardsi New, 1974b: 292.
Tanystigma edwardsi. --- Smithers, 1983: 77.

New (1974b) described this species from material consisting of males only. Both sexes were collected from Tasmania, and a description of the female is provided.

Material examined. Specimen on which description based: Tasmania, 1♀, Cape Tourville, *Leptospermum grandiflorum*, 5 Dec 1986. Additional records: **site** 77, 1♂, 2 nymphs 4 Feb 87; 6♀, 22 Mar 87; 1♂, 21 Feb 88; **site** 86, 1♀, 21 Mar 87; 2♀, 1♂, 22 Apr 87; 1♂, 20 Feb 88; **site** 88B, 1♂, 11 May 87; **site** 95A, 1♀, 20 Feb 88.

Distribution. Tasmania and Victoria.

Description of female. *Coloration* (after ca 5 years in alcohol). Head paler than that of male. Usual markings on back of vertex, dorsal to eyes and along epicranial suture dark brown. Ocelli internally bordered black. Black lines extending from lateral ocelli to antennal bases not present. Brown mark extending from back of eye along its ventral margin to brown ring of antenna base. Brown stirrup mark on frons. Striae on postclypeus very pale. Labrum and anteclypeus colorless. Eyes black. Maxillary palp pale except dark brown apical segment. Fore wing (fig. 249) with complete brown fascia. Hind wing (fig. 250) hyaline. Thorax, legs and abdomen as male.

Morphology. IO:D = 3.7. Fore wing (fig. 249): fine sparse setae on margin and veins; both sections of vein cu_{1a} at a distinct angle, basal section longer than apical section; spur-vein from pterostigma present. Hind wing (fig. 250) with few fine setae on margin between r_{2+3} and r_{4+5} . Epiproct (fig. 251) with pair of lateral longitudinal sclerotised bars. Paraproct (fig. 251) with round field of 27 trichobothria, apical margin setose. Subgenital plate (fig. 252) with setose median lobe, pigmentation arms converging posteriorly fusing at basal section of lobe. Gonapophyses (fig. 253): ventral and dorsal valves with narrow spiculate apical spine; external valve with large posterior lobe and small apical dorsal lobe. Spermathecal plate (fig. 253).

Dimensions. B 3.0, FW 2.74, HW 2.06, F 0.58, T 1.08, t_1 0.284, t_2 0.178, rt 1.6:1, ct 16.0, f_1 0.600, f_2 0.506.

Remarks. In fore wing pigmentation the females of *T. edwardsi*

most resemble the larger *T. inglewoodense*. The pigmentation of the pterostigma is more extensive in the latter species, however the pigmentation surrounding the $rs + m$ vein junction is more extensive in *T. edwardsi*. The two species differ markedly in the shape and extent of the lateral sclerotised bars of the female epiproct (not figured for *T. inglewoodense* by New, 1974b), in the pattern of pigmentation of the subgenital plate and in the structure of the spermathecal plate (not figured or mentioned for *T. inglewoodense* by New, 1974b). The males from Tasmania are smaller (fore wing length about 4.0 mm) than those described from Victoria (fore wing length about 4.5 mm), and have a stirrup mark on the frons, a feature not mentioned in the original description by New (1974b). However, on the balance of other characters, specimens of this species are provisionally referred to *edwardsi*. This species has a limited distribution and a dry coastal scrub habitat preference similar to *P. freycineti*, but is also found in dry forest. It was taken from December to May.

Tanystigma inglewoodense (New)

Clematostigma inglewoodense New, 1974b: 296.
Tanystigma inglewoodense. --- Smithers, 1983: 77.

Material examined. Many individuals collected from February to July.

Distribution. Tasmania and Victoria.

Remarks. The IO:D measured for males of this species by Schmidt and Thornton (1993) is incorrect; the correct value is indicated in the above key. This species is predominantly coastal and limited to the northern half of the state where it was found in dry coastal scrub, wet scrub, and in the heath understorey of dry and wet forests.

Tanystigma tardipes (Edwards)

Clematostigma tardipes Edwards, 1950: 95.
Tanystigma tardipes. --- Smithers, 1983: 77.

Material examined. Many individuals collected from January to July.

Distribution. Tasmania, Bass Strait Is, Victoria and South Australia.

Remarks. This species is restricted to dry coastal scrub and dry forest sites along the east coast from South Arm Recreation Area to Eddystone Point.

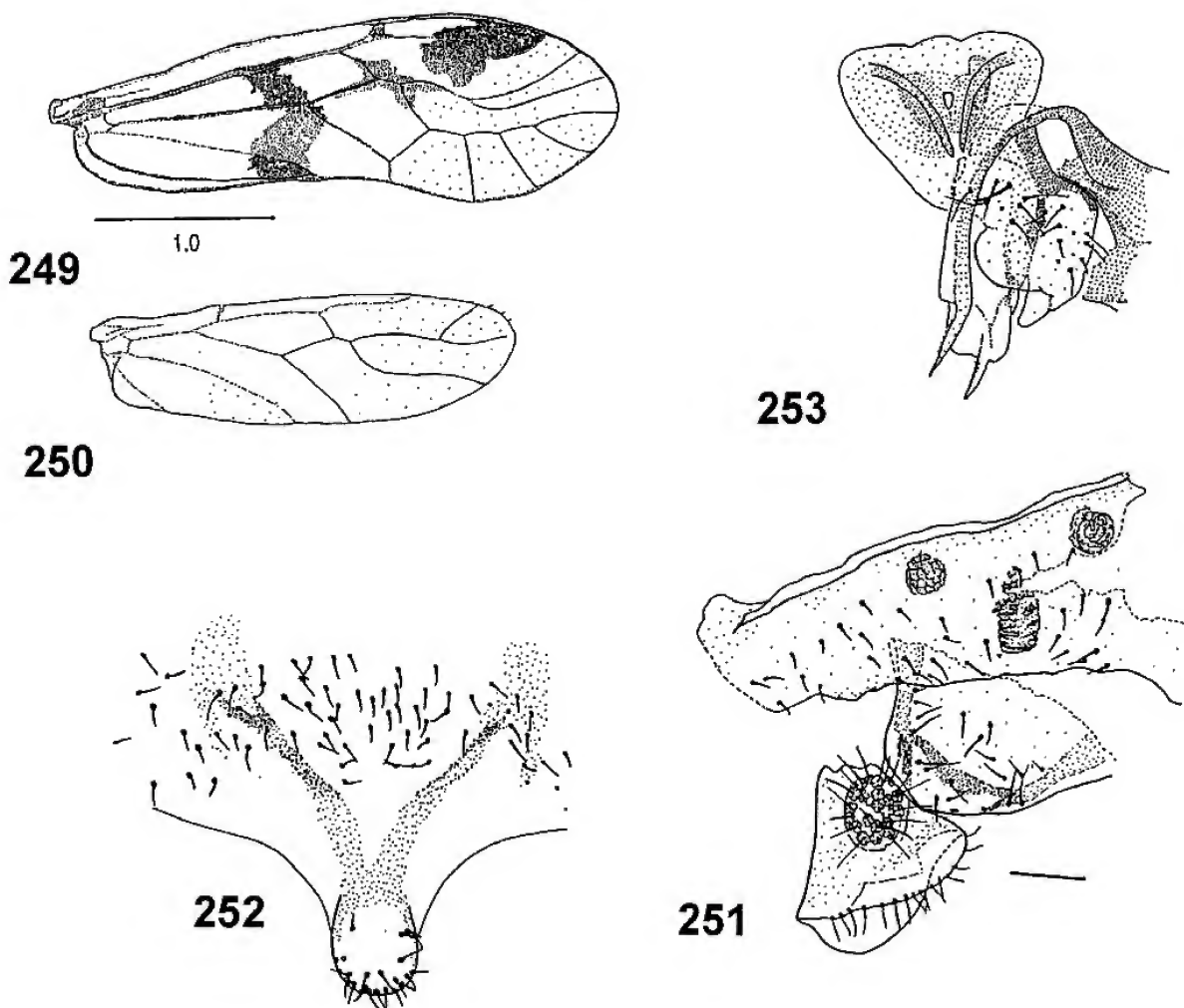
Myopsocidae

Nimbopsocus Smithers

Nimbopsocus Smithers, 2004: 160. Type species: *Nimbopsocus thorntoni* Smithers.

Key to Tasmanian species of *Nimbopsocus*

1. Female body length 4.4–4.8 mm, male body length 2.9–3.1 mm *australis* (Brauer)
- Female body length 3.6–3.8 mm, male body length 2.0–2.1 mm *hickmani* (Smithers)



Figures 249-253. *Tanystigma edwardsi*. Female: 249, fore wing; 250, hind wing; 251, epiproct and paraproct; 252, subgenital plate; 253, gonapophyses and spermathecal plate. Figures 249, 250 and 251-253 to common scales.

***Nimbopsocus australis* (Brauer)**

Psocus australis Brauer, 1865: 908.

Myopsocus australis. --- Kolbe, 1883a: 145.

Nimbopsocus australis. --- Smithers, 2004: 162.

Material examined. Site 77, 1♂, 22 Mar 87; site 104, 1♀, 4 Feb 87.

Distribution. Tasmania, Flinders I (Bass Strait), all mainland states (except Northern Territory), Norfolk I, Lord Howe I, Solomon Is, Kermadecs and New Zealand.

***Nimbopsocus hickmani* (Smithers)**

Myopsocus australis (Brauer). Hickman, 1934: 85.

Myopsocus griseipennis (McLachlan). Edwards, 1950: 104.

Myopsocus hickmani Smithers, 1964: 135.

Nimbopsocus hickmani. --- Smithers, 2004: 162.

Distribution. Tasmania and Victoria.

Remarks. This species was not collected during the present study.

Discussion

The Psocoptera of Tasmania is far richer than supposed previously, and this work has also demonstrated the considerable wider biogeographical and evolutionary interest of this fauna. Interpretation can still only be rather tentative. Some parts of the state, particularly in the remote southwest, remain undercollected and some specialised habitats – such as karst caves – likely to support species of Psocoptera have not been surveyed for these insects.

Nevertheless, as noted by Schmidt and New (2004b), some distributional interpretation is possible. Several faunal elements are evident, and reflected in richness of particular families. About 15 species are cosmopolitan, 32 species appear to be endemic to Tasmania, almost the same number are known only from southeastern Australia, and others are more widespread in Australia or shared with New Zealand or other nearby countries. This survey has not led to augmentation of some families (such as Lepidopsocidae and Trichopsocidae), but has indicated the presence of Tasmanian diversification in other families such as Caeciliusidae (with five new genera, two of them in a new tribe), Elipsocidae (with four endemic genera: Schmidt and New, 2004a), both of which merit further study to clarify evolutionary relationships, and additional species in Ectopsocidae and Psocidae (5 each) and other families. Many of the newly described taxa, despite the extensive field work on which this study is founded, were captured in only small numbers, and from single or few sites. Some, indeed, may prove to be narrow-range endemics within Tasmania, and to have specialised habitat associations as “genuinely rare species” that could be or become vulnerable as their environments change.

The topographic and vegetational diversity of Tasmania supports one of the richest global southern arrays of Psocoptera, many associated with particular vegetation systems. As Schmidt and New (2004b) noted, it is still premature to define the biogeography of psocids in southeastern Australia. However, information available to date supports the expected considerable affinity with more natural parts of Victoria (such as Wilsons Promontory: Schmidt and Thornton, 1993), with a strong complement of taxa constituting a southeastern Australian regional fauna transcending Bass Strait and extending northward along the east coast, some of which are likely Gondwanan elements.

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References

- Badonnel, A. 1931. Contribution à l'étude de la faune du Mozambique. Voyage de M. P. Lesne (1928–1929). 4^e note: Copéognathes. *Annales des Sciences Naturelles, Zoologie* (10^e série) 14: 229–60.
- Badonnel, A. 1945. Contribution à l'étude des Psocoptères du Maroc. Voyage de L. Berland et M. Vachon. *Revue Française d'Entomologie* 12: 31–50.
- Badonnel, A. 1955. Psocoptères de L'Angola. *Publicacoes Culturais da Companhia de Diamantes de Angola* 26: 1–267.
- Badonnel, A. 1962. Psocoptères. *Biologie de l'Amérique australe* 1: 185–229.
- Badonnel, A. 1963. Psocoptères terricoles, lapidicoles et corticoles du Chili. *Biologie de l'Amérique australe* 2: 291–388.
- Badonnel, A. 1972. Espèces brésiliennes de la sous-famille des Embidopsocinae (Psocoptera: Liposcelidae). *Bulletin du Muséum National d'Histoire Naturelle* (3^e série) 87: 1097–1139.
- Badonnel, A., and Pearman, J.V. 1971. *Mascaropsocus*, nouveau genre d'Ectopsocinae des Iles Mascareignes (Psocoptera, Peripsocidae). *Bulletin du Muséum National d'Histoire Naturelle* (2^e série) 42: 857–63.
- Ball, A. 1943. Contribution à l'étude des Psocoptères. III. *Bulletin du Musée Royal d'Histoire Naturelle de Belgique* 19: 1–28.
- Banks, N. 1903. Some new neuropteroid insects. *Journal of the New York Entomological Society* 11: 236–43.
- Banks, N. 1908. Neuropteroid insects – notes and descriptions. *Transactions of the American Entomological Society* 34: 255–67.
- Banks, N. 1939. New genera and species of neuropteroid insects. *Bulletin of the Museum of Comparative Zoology at Harvard College* 85: 439–504.
- Blom, W.M. 1988. Late Quaternary sediments and sea-levels in Bass Basin, southeastern Australia – a preliminary report. *Search* 19: 94–96.
- BMR Palaeographic Group 1990. *Australia: Evolution of a Continent*. Bureau of Mineral Resources, Geology and Geophysics, Australia. Australian Government Publishing Service: Canberra.
- Brauer, F. 1865. Vierter Bericht über die auf der Weltfahrt der kais. Fregatte Novara gesammelten Neuropteren. *Verhandlungen. Zoologisch-Botanische Gesellschaft in Wien* 15: 903–08.
- Brown, M.J. 1981. Introduction. Pp. 104–06. in: Jackson, W.D. (ed) *The Vegetation of Tasmania*. Australian Academy of Science: Canberra.
- Buchanan, A.M. 2007. A census of the vascular plants of Tasmania. Tasmanian Herbarium: Hobart: www.tmag.tas.gov.au/herbarium/TasVascPlants.pdf (Last accessed 6 September 2008.)
- Cole, P.G., New, T.R., and Thornton, I.W.B. 1989. Psocoptera of Flinders, King and Deal Islands, Bass Strait. *Journal of the Australian Entomological Society* 28: 31–38.
- Coy, R., Greenslade, P., and Rounsevell, D. 1993. *A survey of Invertebrates in Tasmanian Rainforest*. Tasmanian NRCP Technical Report no. 9. Parks and Wildlife Service, Tasmania, and Department of Arts, Sport and the Environment and Territories, Canberra.

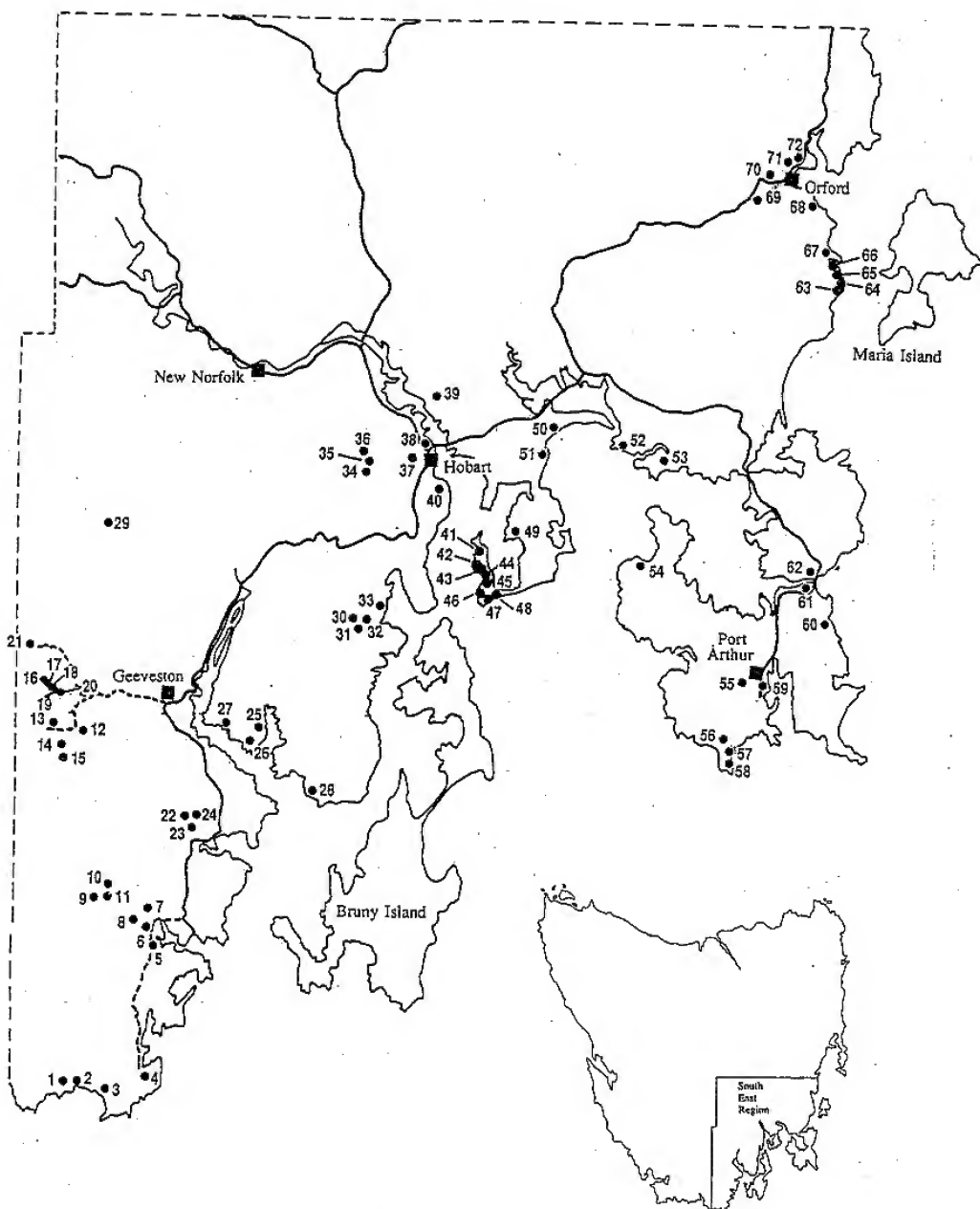
- Davies, J.L. 1965. Landforms. Pp. 19–25 in: Davies, J.L. (ed.), *Atlas of Tasmania*. Mercury Press: Hobart.
- Duncan, F. 1981. Dry sclerophyll communities. Pp. 61–67 in: Jackson, W.D. (ed), *The Vegetation of Tasmania*. Australian Academy of Science: Canberra.
- Duncan, F. 1985. *Tasmania's Vegetation and Its Response to Forest Operations*. Working Paper 6. Background to the EIS on Tasmanian Woodchip Exports beyond 1988. Forestry Commission: Tasmania.
- Duncan, F., and Brown, M.J. 1985. *Dry Sclerophyll Vegetation in Tasmania*. Wildlife Division Technical Report 85/1. National Parks and Wildlife Service: Tasmania.
- Edwards, B.A.B. 1950. A study of the Tasmanian Psocoptera with descriptions of new species. *Papers and Proceedings of the Royal Society of Tasmania* 1949: 93–134.
- Enderlein, G. 1903. Die Copeognathen des indo-australischen Faunengebietes. *Annales Historico-naturales Musei Nationalis Hungarici* 1: 179–344.
- Enderlein, G. 1905. Morphologie, Systematik und Biologie der Atropiden und Troctiden sowie Zusammenstellung aller bisher bekannten recenten und fossilen Formen. *Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901*. 18: 1–58.
- Enderlein, G. 1906. Die australische Copeognathen. *Zoologischen Jahrbüchern. Abteilung für Systematik, Geographie und Biologie der Thiere* 23: 401–12.
- Enderlein, G. 1919. Copeognatha. *Collections Zoologique du Baron Edm. de Selys Longchamps* 3: 1–55.
- Enderlein, G. 1922. A scaly-winged Psocid, new to science, discovered in Britain. *Entomologist's Monthly Magazine* 58: 101–04.
- Enderlein, G. 1925. Beiträge zur Kenntnis der Copeognathen. IX. *Konowia* 4: 97–108.
- Enderlein, G. 1926. Die Copeognathenfauna Javas. *Zoologische Mededeelingen* 9: 50–70.
- Endersby, N.M., New, T.R., and Thornton, I.W.B. 1990. Psocoptera from the Grampians and Mt Arapiles, Western Victoria: a biogeographic analysis. *Journal of the Australian Entomological Society* 29: 215–24.
- Feary, D.A., Davies, P.J., Pigram, C.J., and Symonds, P.A. 1991. Climatic evolution and control on carbonate deposition in northeast Australia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 89: 341–61.
- Guiler, E.R. 1965. Animals. Pp. 36–37 in: Davies, J.L. (ed), *Atlas of Tasmania*. Mercury Press: Hobart.
- Hagen, H. 1866a. On some aberrant genera of Psocina. *Entomologist's Monthly Magazine* 2: 170–72.
- Hagen, H. 1866b. Psocinorum et Embidinorum Synopsis synonymica. *Verhandlungen. Zoologisch-Botanische Gesellschaft in Wien* 16: 201–22.
- Heyden, G.H. 1850. Zwei neue deutsche Neuropterengattungen. *Stettiner Entomologische Zeitung* 11: 83–85.
- Hickman, V.V. 1934. A contribution to the study of Tasmanian Copeognatha. *Papers and Proceedings of the Royal Society of Tasmania* 1933: 77–89.
- Hope, G.S. 1978. The late Pleistocene and Holocene vegetational history of Hunter Island, north-western Tasmania. *Australian Journal of Botany* 26: 493–514.
- Illiger, J.C.W. 1798. *Kugelann Verzeichniss der Kafer Preussens asugearbeitet von Illiger, mit einer vorrede von Hellwig und dem angehangten Versuch einer natürlichen Ordnung und Gattungsfolge der Insecten*. Halle. Xli+510 pp.
- Jackson, W.D. 1981a. Vegetation. Pp. 11–16 in: Jackson, W.D. (ed), *The Vegetation of Tasmania*. Australian Academy of Science: Canberra.
- Jackson, W.D. 1981b. Fire patterned vegetation. Pp. 17–35 in: Jackson, W.D. (ed), *The Vegetation of Tasmania*. Australian Academy of Science: Canberra.
- Jackson, W.D. 1981c. Wet sclerophyll. Pp. 68–72 in: Jackson, W.D. (ed), *The Vegetation of Tasmania*. Australian Academy of Science: Canberra.
- Jarman, S.J., and Brown, M.J. 1983. A definition of cool temperate rainforest in Tasmania. *Search* 14: 81–87.
- Jarman, S.J., Brown, M.J., and Kantvilas, G. 1984. *A classification of cool temperate rainforest in Tasmania*. National Parks and Wildlife Service: Tasmania.
- Kirkpatrick, J.B. 1977. *The Disappearing Heath*. Tasmanian Conservation Trust: Hobart.
- Kirkpatrick, J.B. 1981. Coastal, Heath and Wetland vegetation. Pp. 36–54 in: Jackson, W.D. (ed), *The Vegetation of Tasmania*. Australian Academy of Science: Canberra.
- Kirkpatrick, J.B., and Dickinson, K.J.M. 1984. *Vegetation Map of Tasmania*, 1: 500 000. Tasmanian Forestry Commission: Hobart.
- Kirkpatrick, J.B., Peacock, R.J., Cullen, P.J., and Neyland, M.G. 1988. *The Wet Eucalypt Forests of Tasmania*. Tasmanian Conservation Trust: Hobart.
- Kolbe, H.J. 1880. Monographie der deutschen Psociden mit besonderer Berücksichtigung der Fauna West-falens. *Jahresbericht des Westfälischen Provinzial-Vereins für Wissenschaft und Kunst* 8: 73–142.
- Kolbe, H.J. 1882a. Das phylogenetische Alter der europäischen Psocidengruppen. *Jahresbericht des Westfälischen Provinzial-Vereins für Wissenschaft und Kunst* 10: 18–27.
- Kolbe, H.J. 1882b. Neue Psociden der palaäarktischen Region. *Entomologische Nachrichten* 8: 207–12.
- Kolbe, H.J. 1883a. Ueber das Genus *Myopsocus* und dessen species. *Entomologische Nachrichten* 9: 141–46.
- Kolbe, H.J. 1883b. Neue Psociden des Königl. zoologischen Museums zu Berlin. *Stettiner Entomologische Zeitung* 44: 65–87.
- Langford, J. 1965. Weather and Climate. Pp. 2–11 in: Davies, J.L. (ed), *Atlas of Tasmania*. Mercury Press: Hobart.
- Lee, S.S., and Thornton, I.W.B. 1967. The family Pseudocaeciliidae (Psocoptera) – a reappraisal based on the discovery of new Oriental and Pacific species. *Pacific Insects Monograph* 16: 1–116.
- Li Fasheng, 1993. Psocoptera from National Chebaling Nature Reserve (Insecta: Psocoptera). Pp. 313–430 in: *Collected Papers for Investigation in National Chebaling Nature Reserve*. Science and Technology Publishing House of Guangdong Province: China.
- Li Fasheng, 2000. A review of *Heterocaecilius* (s. l.) with the description of two new genera and new species (Psocoptera: Pseudocaeciliidae). *Contributions from Tianjin Natural History Museum* 17: 18–24.
- Lienhard, C. 1990. Revision of the western Palaearctic species of *Liposcelis* Motschulsky (Psocoptera: Liposcelididae). *Zoologische Jahrbücher (Abteilung Systematik)* 117: 117–74.
- Lienhard, C. 1998. Psocoptères euro-méditerranéens. *Faune de France* 83: xx+517 pp.
- Lienhard, C., and Smithers, C.N. 2002. Psocoptera (Insects). World Catalogue and Bibliography. *Instrumenta Biodiversitatis* 5: xli+745 pp. Muséum d'Histoire naturelle, Genève.
- Linnaeus, C. 1758. *Systema Naturae per regna tria naturae secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Ed. decima reformata. Holmiae.
- McLachlan, R. 1866. New genera and species of Psocidae. *Transactions of the Entomological Society of London* 5: 345–52.
- McLachlan, R. 1899. *Ectopsocus briggsi*, a new genus and species of Psocidae found in England. *Entomologist's Monthly Magazine* 35: 277–78.

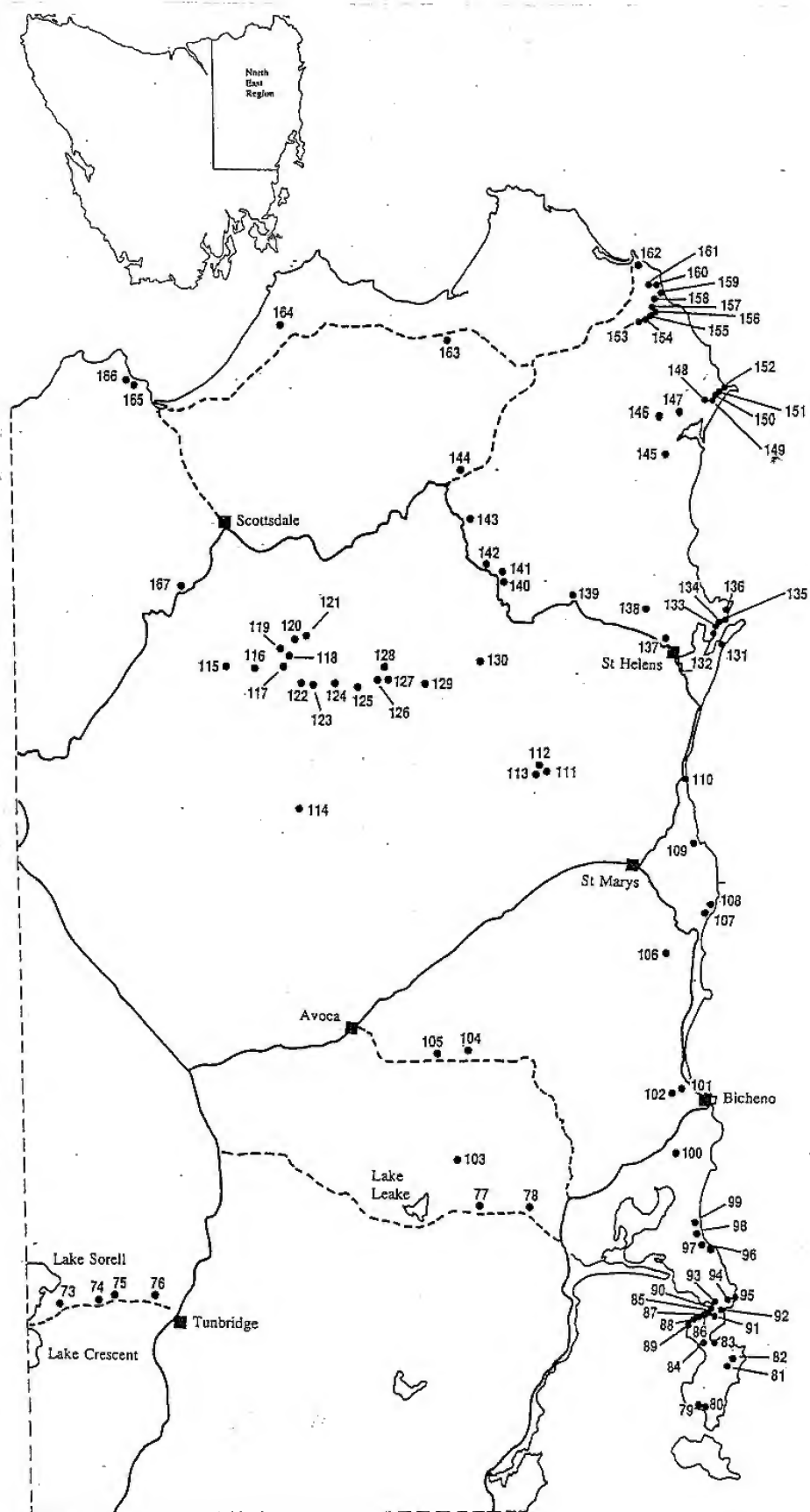
- Mockford, E.L. 1951. On two North American philotarsids (Psocoptera). *Psyche, a Journal of Entomology* 58: 102–07.
- Mockford, E.L. 1963. The species of Embidopsocinae of the United States (Psocoptera: Liposcelidae). *Annals of the Entomological Society of America* 56: 25–37.
- Mockford, E.L. 1987. Systematics of North American and Greater Antillean species of *Embidopsocus* (Psocoptera: Liposcelidae). *Annals of the Entomological Society of America* 80: 849–64.
- Mockford, E.L. 2000. A classification of the psocopteran family Caeciliusidae (Caeciliidae auct.). *Transactions of the American Entomological Society* 125: 325–417.
- Motchulsky, V. 1852. *Etudes entomologiques*. Helsingfors.
- Navas, L. 1924. Excursio entomologica al Cabrerres (Girona-Barcelona). *Trabajos del Museo de Ciencias naturales de Barcelona* 4: 1–59.
- New, T.R. 1971. The Psocoptera of Curtis Island, Tasmania. *Journal of the Australian Entomological Society* 10: 223–29.
- New, T.R. 1973a. New species and records of *Peripsocus* Hagen (Psocoptera, Peripsocidae) from southeast Australia. *Journal of the Australian Entomological Society* 12: 340–46.
- New, T.R. 1973b. Two new Victorian species of *Ectopsocus* McLachlan (Psocoptera, Ectopsocidae). *Journal of the Australian Entomological Society* 12: 347–51.
- New, T.R. 1974a. New species and records of Pseudocaeciliidae (Psocoptera) from southeast Australia. *Journal of the Australian Entomological Society* 13: 65–70.
- New, T.R. 1974b. Psocidae (Psocoptera) from southern Australia. *Journal of the Australian Entomological Society* 13: 285–304.
- New, T.R. 1975. Aerial dispersal of some Victorian Psocoptera as indicated by suction trap catches. *Journal of the Australian Entomological Society* 14: 179–84.
- New, T.R., and Thornton, I.W.B. 1981. Psocoptera from central and southern Chile. *Pacific Insects Monograph* 37: 136–78.
- Pearman, J.V. 1931. A new species of *Lepinotus* (Psocoptera). *Entomologist's Monthly Magazine* 67: 47–50.
- Pearman, J.V. 1936. The Taxonomy of the Psocoptera: Preliminary Sketch. *Proceedings of the Royal Entomological Society of London* (B) 5: 58–62.
- Peck, O. 1951. Superfamily Chalcidoidea. Pp 410–594 in: Muesebeck, C.F.W., Krombein, K.V. and Townes, H.K. (eds), Hymenoptera of North America north of Mexico [synoptic catalog.]. *United States Department of Agriculture. Agriculture Monograph* 2.
- Perkins, R.C.L. 1899. *Fauna Hawaiensis*. Cambridge University Press: Cambridge.
- Reid, J.B., Hill, R.S., Brown, M.J., and Hovenden, M.J. (eds) 1999. *Vegetation of Tasmania*. Flora of Australia Supplementary series no. 8. Australian Biological Resources Study: Canberra.
- Ribaga, C. 1905. Descrizione di nuovi Copeognati. *Redia* 2: 99–110.
- Roesler, R. 1943. Über einige Copeognathengenera. *Stettiner Entomologische Zeitung* 104: 1–14.
- Roesler, R. 1944. Die Gattungen der Copeognathen. *Stettiner Entomologische Zeitung* 105: 117–66.
- Schmidt, E.R., and Thornton, I.W.B. 1993. The Psocoptera of Wilsons Promontory National Park, Victoria, Australia. *Memoirs of the Museum of Victoria* 53: 137–220. [Erratum 1994, 54: before page 1]
- Schmidt, E.R., and New, T.R. 2004a. A systematic and phylogenetic revision of the family Elipsocidae (Insecta: Psocoptera), with the erection of two new families: Lesneiidae and Sabulopsocidae. *Invertebrate Systematics* 18: 157–213.
- Schmidt, E.R., and New, T.R. 2004b. Biogeography of the Psocoptera of Tasmania, Australia: a preliminary synthesis. Pp. 67–77 in: Garcia Aldrete, A.N., Lienhard, C., and Mockford, E.L. (eds), *Thorntoniana: a commemorative volume for Ian W.B. Thornton*. Publicaciones Especiales 20, Mexico: Instituto de Biología, UNAM.
- Schmidt, E.R., and Smithers, C.N. 2004. The genus *Howeanum* Smithers (Psocoptera: Elipsocidae) transferred to the family Pseudocaeciliidae. *General and Applied Entomology* 33: 13–14.
- Selys-Longchamps, E. de 1872. Notes on two new genera of Psocidae. *Entomologist's Monthly Magazine* 9: 145–46.
- Smithers, C.N. 1962. Insects of Macquarie Island. Psocoptera: Philotarsidae. *Pacific Insects* 4: 929–32.
- Smithers, C.N. 1963. Two new genera of Elipsocidae (Psocoptera) from Australia. *Proceedings of the Royal Entomological Society of London* (B) 32: 32–37.
- Smithers, C.N. 1964. The Myopsocidae of Australia. *Proceedings of the Royal Entomological Society of London* (B) 33: 133–38.
- Smithers, C.N. 1969. The Psocoptera of New Zealand. *Records of the Canterbury Museum* 8: 259–344.
- Smithers, C.N. 1972. The Classification and Phylogeny of the Psocoptera. *Australian Museum Memoir* 14: 1–349.
- Smithers, C.N. 1977. The Psocoptera of Muogamarra Nature Reserve. *Records of the Australian Museum* 31: 251–306.
- Smithers, C.N. 1978. A new species and new records of Psocoptera (Insecta) from Ireland. *Irish Naturalists' Journal* 19: 141–48.
- Smithers, C.N. 1979. Three new species and some records of Psocoptera (Insecta) from Tasmania. *Australian Entomological Magazine* 6: 61–68.
- Smithers, C.N. 1982. *Aphyopsocus* gen. nov., a remarkable new genus of Caeciliidae (Psocoptera) from southeastern New South Wales. *Australian Entomological Magazine* 9: 13–18.
- Smithers, C.N. 1983. A reappraisal of *Clematostigma* Enderlein with notes on related genera (Psocoptera: Psocidae). *Australian Entomological Magazine* 9: 71–79.
- Smithers, C.N. 1984. The Psocoptera of South Australia. *Records of the South Australian Museum* 18: 453–91.
- Smithers, C.N. 1991. Psocoptera (Insecta) from Nest Webs of *Badumna candida* (L. Koch) (Desidae: Araneae) in Queensland. *Proceedings of the Linnean Society of NSW* 112: 27–31.
- Smithers, C.N. 1993. New species and new records of Caeciliinae (Psocoptera: Caeciliidae) from the Mount Royal area, Hunter Valley, New South Wales, with a key to the Australian species of *Caecilius* Curtis. *General and Applied Entomology* 25: 15–21.
- Smithers, C.N. 1994a. Generic positions of Australian Psocoptera currently placed in *Paracaecilius* Badonnel and *Enderleinella* Badonnel (Insecta: Psocoptera: Caeciliidae). *Records of the Australian Museum* 46: 125–29.
- Smithers, C.N. 1994b. A note on the Peripsocidae (Psocoptera) of Tuglo Wildlife Refuge, Hunter Valley, New South Wales. *Australian Entomologist* 21: 7–10.
- Smithers, C.N. 1995. Psocoptera from inflorescences of *Howea forsteriana* (C. Moore and F.J. Muell) Becc. (Arecaceae) (thatch palm) on Lord Howe Island. *General and Applied Entomology* 26: 2–8.
- Smithers, C.N. 1996a. Psocoptera [pp. 1–79, 333–35 (App. I–II), 363–72 (Index)] in: Wells, A (ed.), *Zoological Catalogue of Australia* vol. 26. Psocoptera, Phthiraptera, Thysanoptera. CSIRO Publishing: Melbourne.
- Smithers, C.N. 1996b. New species and new records of Pseudocaeciliidae, Philotarsidae and Elipsocidae (Insecta: Psocoptera) from the Mount Royal area, Hunter Valley, New South Wales. *Proceedings of the Linnean Society of New South Wales* 116: 233–43.
- Smithers, C.N. 1996c. Psocoptera from the Western Australian wheatbelt. *General and Applied Entomology* 27: 13–18.
- Smithers, C.N. 1996d. New species and new records of Ectopsocidae (Insecta: Psocoptera) from the Mount Royal area, Hunter Valley, New South Wales. *General and Applied Entomology* 27: 43–48.

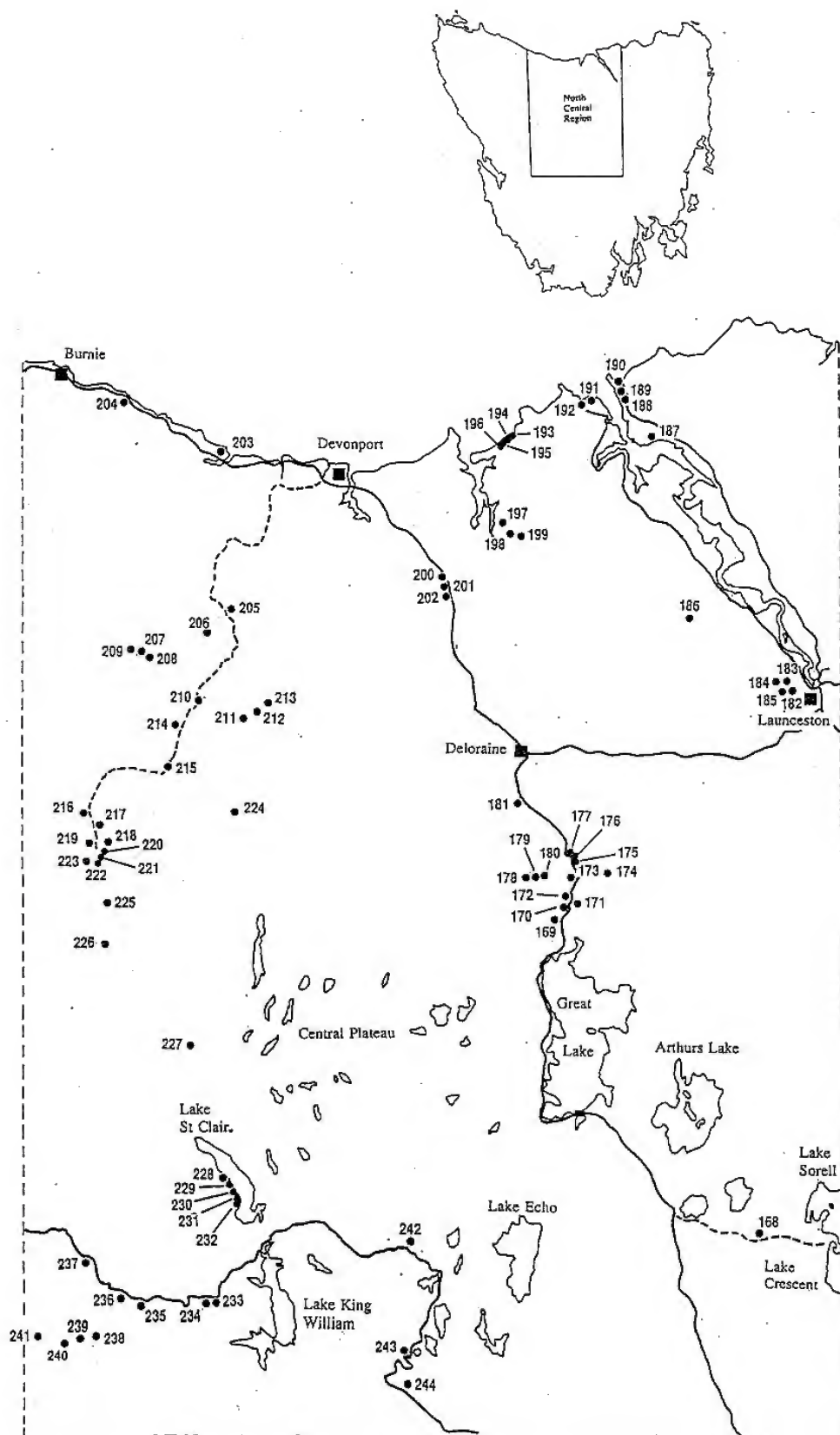
- Smithers, C.N. 1997. Lepidopsocidae, Trogiidae, Myopsocidae and Psocidae (Insecta: Psocoptera) from the Mount Royal area, New South Wales. *Proceedings of the Linnean Society of New South Wales* 118: 111–21.
- Smithers, C.N. 1998. New species and new records of Psocoptera (Insecta) from South Australia. *Proceedings of the Linnean Society of New South Wales* 120: 69–79.
- Smithers, C.N. 2002. First record of the family Trichopsocidae (Psocoptera) from New Zealand. *Entomologist's Monthly Magazine* 138: 155.
- Smithers, C.N. 2003. The identity and nomenclature of some species of *Ectopsocus* McLachlan (Psocoptera, Ectopsocidae) common to the Palaearctic, Nearctic and Australasian regions. *Entomologist's Monthly Magazine* 139: 1–6.
- Smithers, C.N. 2004. A new genus for the species of Australian Myopsocidae (Insecta: Psocoptera). Pp. 159–68 in: Garcia Aldrete, A.N., Lienhard, C., and Mockford, E.L. (eds), *Thorntoniana: a commemorative volume for Ian W.B. Thornton*. Publicaciones Especiales 20, Mexico: Instituto de Biología, UNAM.
- Smithers, C.N., and O'Connor, J.P. 1991. New records of Psocoptera (Insecta) (booklice, barklice) from Ireland, including a species previously known from New Zealand. *Irish Naturalists Journal* 23: 477–86.
- Thomas, S.R. 1986. *A survey of the Psocopteran fauna at Cape Otway National Park, Victoria*. Unpublished Honours thesis: La Trobe University.
- Thornton, I.W.B. 1959. A new genus of Philotarsidae (Corrodentia) and new species of this and related families from Hong Kong. *Transactions of the Royal Entomological Society of London* 111: 331–49.
- Thornton, I.W.B. 1981. The systematics, phylogeny and biogeography of the Psocopteran family Philotarsidae. *Systematic Entomology* 6: 413–52.
- Thornton, I.W.B., and New, T.R. 1977. The Philotarsidae (Insecta: Psocoptera) of Australia. *Australian Journal of Zoology Supplementary Series* 54: 1–62.
- Thornton, I.W.B., and Wong, S.K. 1968. The Peripsocid fauna (Psocoptera) of the Oriental Region and the Pacific. *Pacific Insects Monograph* 19: 1–158.
- Thornton, I.W.B., Wong, S.K., and Smithers, C.N. 1977. The Philotarsidae (Psocoptera) of New Zealand and the islands of the New Zealand plateau. *Pacific Insects* 17: 197–228.
- Tillyard, R.J. 1923. A Monograph of the Psocoptera, or Copeognatha, of New Zealand. *Transactions of the New Zealand Institute* 54: 170–96.
- Truswell, E.M. 1993. Vegetation Changes in the Australian Tertiary in Response to Climatic and Phytogeographic Forcing Factors. *Australian Systematic Botany* 6: 533–57.
- Veevers, J.J., Powell, C.McA., and Roots, S.R. 1991. Review of seafloor spreading around Australia. I. Synthesis of patterns of spreading. *Australian Journal of Earth Sciences* 38: 373–89.
- Westwood, J.O. 1840. *Synopsis of the genera of British Insects*. London.
- Yoshizawa, K. 2000. Redescription of *Mepleres suzukii* (Okamoto), with comments on synonymy among *Mepleres*, *Pseudoscottiella* and *Meniscopsocus* (Psocodea: 'Psocoptera': Pseudocaeciliidae). *Entomological Science* 3: 669–74.
- Zimmerman, E.C. 1957. *Insects of Hawaii*. Vol. 6. *Ephemeroptera-Neuroptera-Trichoptera* and Supplement to volumes 1–5. University of Hawaii Press: Honolulu.

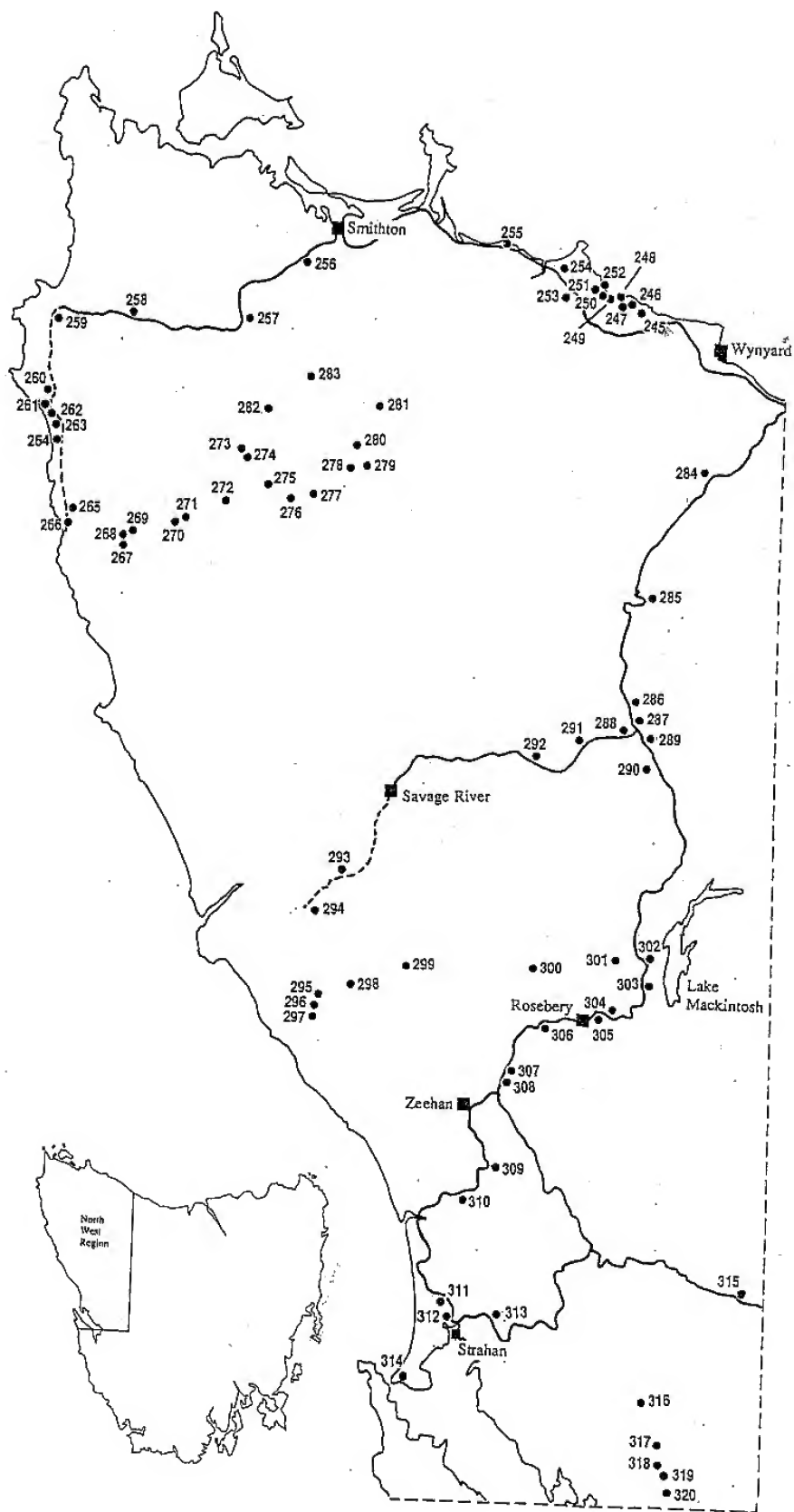
Appendices 1 and 2

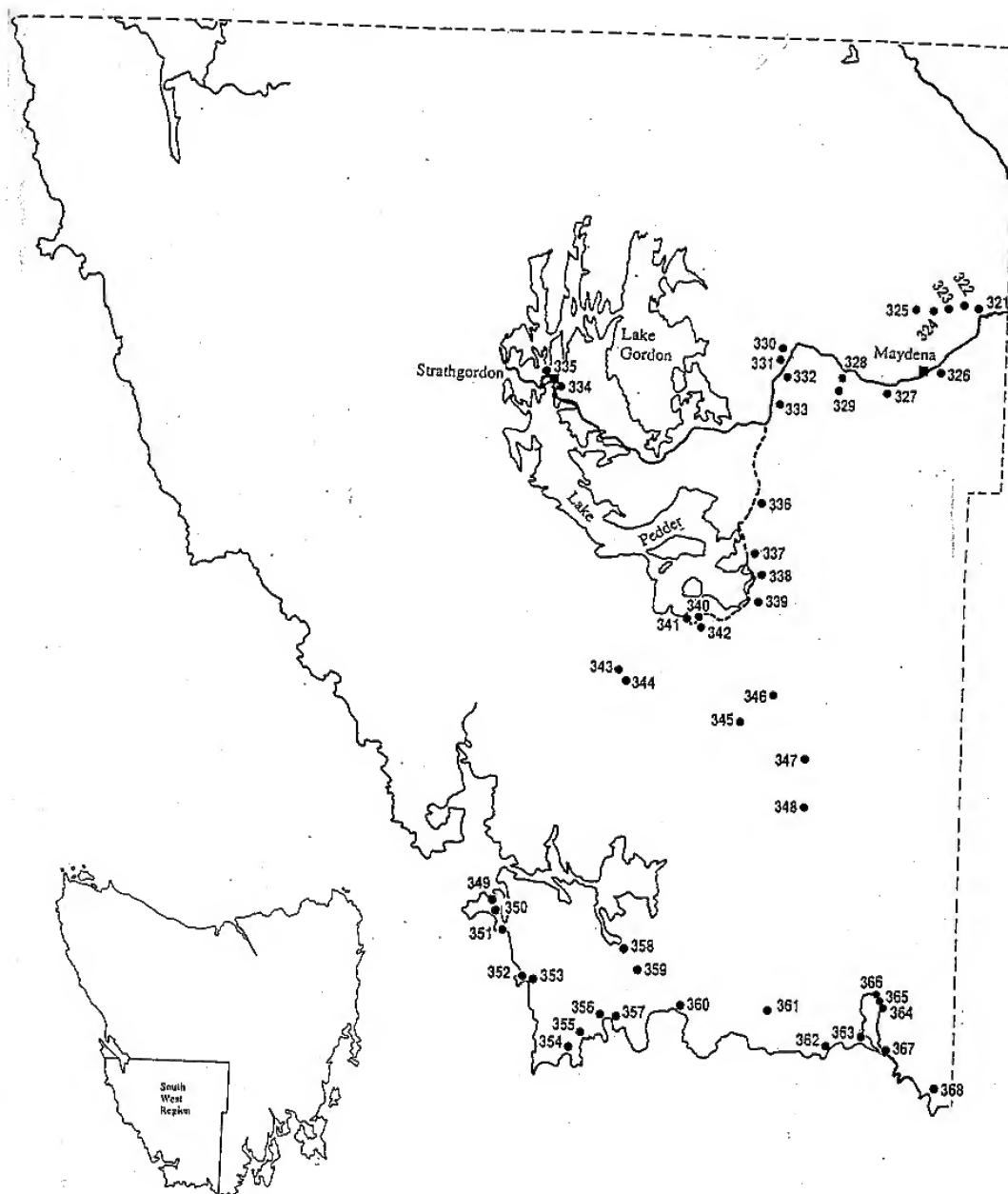
Maps and Tables of all collecting localities for Psocoptera in Tasmania visited during this survey on <http://www.museumvictoria.com.au/About/Books-and-Journals/Journals/Memoirs-of-Museum-Victoria>











The Psocoptera (Insecta) of Tasmania, Australia

E.R. Schmidt & T.R.New

APPENDIX

Site numbers, localities, vegetation types and dates (1986-1988) of sampling for Psocoptera from Tasmania. Sites are shown on accompanying maps. Psocoptera were not collected from sites sampled and indicated by (x).

SOUTHEAST TASMANIA

Site	Locality	Vegetation	Date
1	South Cape Rivulet, South Coast Tk	Rainforest	28 Mar 88 (x)
2	South Cape Rivulet	Coastal scrub	29 Mar 88
3	Cockle Ck, South Coast Tk	Coastal scrub	21 June 86, 19 Nov 86
4	Cockle Ck	<i>Leptospermum lanigerum</i>	21 June 86
5A	Ida Bay State Reserve	<i>Acacia melanoxylon</i> (wet forest)	14 Feb 88
5B	Ida Bay State Reserve	<i>Pinus radiata</i>	14 Feb 88
5C	Ida Bay State Reserve	<i>Leptospermum scoparium</i>	14 Feb 88
5D	Ida Bay State Reserve	Bracken	14 Feb 88 (x)
5E	Ida Bay State Reserve	Wet scrub (mainly <i>Melaleuca</i>)	14 Feb 88
6	Lune River, Duck Hole Lake	Rainforest	11 Feb 87
7	Lune River, Coal Hill Road	<i>Acacia melanoxylon</i> (wet forest)	11 Feb 87 (x)
8A	Lune River, Thermal Springs Tk	Swamp forest	14 Feb 88
8B	Lune River, Thermal Springs Tk	Wet forest	14 Feb 88 (x)
9	Hastings Cave	Mixed forest	14 Feb 88
10	Adamsons Falls Tk	Rainforest	21 Nov 86
11	Adamsons Falls Tk	Wet forest	21 Nov 86
12	Hartz Mtns NP	dead <i>Eucalyptus</i> foliage	7 May 87
13	Hartz Mtns NP, Waratah Lkt Tk	dead <i>Leptospermum</i> foliage	7 May 87, 17 Feb 88
14	Hartz Mtns NP, Hartz Peak Tk	Mixed forest	7 May 87
15	Hartz Mtns NP, Hartz Peak Tk	Heath (mainly <i>Leptospermum</i>)	7 May 87 (x)
16A	Arve Loop	<i>Leptospermum nitidum</i>	22 May 86, 15 July 86, 26 Aug 86, 20 Sep 86, 21 Oct 86, 18 Nov 86, 28 Jan

Site	Locality	Vegetation	Date
			87, 26 Feb 87, 31 Mar 87, 24 Apr 87 (x), 28 May 87 (x), 21 June 87, 21 July 87
16B	Arve Loop	<i>Phebalium squameum</i>	15 July 86, 26 Aug 86, 20 Sep 86, 21 Oct 86, 18 Nov 86, 28 Jan 87 (x), 26 Feb 87 (x), 31 Mar 87 (x), 24 Apr 87, 28 May 87 (x), 21 June 87 (x), 21 July 87
16C	Arve Loop	<i>Melaleuca squarrosa</i>	18 Nov 86
16D	Arve Loop	Bracken	28 Jan 87
17	Arve Loop	Mixed forest	22 May 86, 15 July 86, 26 Aug 86, 21 Oct 86, 18 Nov 86, 28 Jan 87 (x), 26 Feb 87, 31 Mar 87, 24 Apr 87, 21 June 87, 21 July 87
18	Arve Loop	Mixed forest	22 May 86, 15 July 86, 26 Aug 86, 20 Sep 86, 21 Oct 86, 18 Nov 86, 28 Jan 87 (x), 26 Feb 87, 31 Mar 87, 24 Apr 87, 29 May 87, 21 June 87, 21 July 87
19A	Arve Loop	Mixed forest	22 May 86, 15 July 86 (x), 26 Aug 86, 20 Sep 86 (x), 21 Oct 86, 18 Nov 86, 28 Jan 87, 26 Feb 87, 31 Mar 87, 24 Apr 87, 29 May 87, 21 June 87 (x), 21 July 87
19B	Arve Loop	Wet forest	21 Oct 86, 18 Nov 86, 31 Mar 87
20	Arve Loop, Spur Rd I.	Mixed forest	22 May 86, 15 July 86, 26 Aug 86, 20 Sep 86, 21 Oct 86, 18 Nov 86, 28 Jan 87, 26 Feb 87, 31 Mar 87, 24 Apr 87, 29 May 87, 21 June 87, 21 July 87
21	Tahune Forest Reserve, Pine Tk	Rainforest	20 Sep 86, 17 Feb 88
22	Dover, Bates Loop	dead <i>Eucalyptus</i> foliage	15 July 86
23	Dover, cnr Hopetoun + Storm Hill Rds	dead foliage (wet/dry forest mosaic)	15 July 86
24	Dover, Hopetoun Rd	dead <i>Eucalyptus</i> foliage	15 July 86
25	Lymington	Wet scrub (mainly <i>Leptospermum scoparium</i> and <i>Melaleuca squarrosa</i>)	13 Feb 88
26A	Drip Beach	<i>Leptospermum scoparium</i>	13 Feb 88
26B	Drip Beach	Bracken	13 Feb 88 (x)
27A	Petchey Bay	Dry forest	13 Feb 88
27B	Petchey Bay	Dry forest	13 Feb 88
28	Verona Sands	<i>Acacia melanoxylon</i> (dry forest)	2 Apr 87
29	Lonna Vale	Wet scrub (mainly <i>Leptospermum scoparium</i>)	14 Feb 88
30	Snug Tiers	Sub-alpine vegetation	9 May 86

Site	Locality	Vegetation	Date
31	Snug Tiers	Sub-alpine vegetation	9 May 86
32	Snug Falls	Wet/dry forest mosaic	1 Aug 86
33	Electrona	Dry forest	8 May 87
34	Mt Wellington, Radfords Tk	<i>Leptospermum lanigerum</i>	19 Feb 87, 6 June 87
35A	Mt Wellington, Finger Post Tk	Wet forest (dead foliage)	20 Feb 87, 6 June 87, 12 Feb 88
35B	Mt Wellington, Finger Post Tk	Wet forest (dead foliage)	20 Feb 87
36	Mt Wellington, Woods Tk	Wet forest (dead <i>Eucalyptus</i> foliage)	21 Feb 87
37	Hobart, Pottery Rd	Dry forest	30 Jan 87 (sweep)
38A	Hobart, Queens Domain	Dry woodland	8 July 86, 1 Oct 86, 29 Jan 87 (sweep)
38B	Hobart, Queens Domain	<i>Acacia melanoxylon</i> (dry woodland)	8 July 86, 8 May 87
38C	Hobart, Queens Domain	Tussock grasses (<i>Poa</i> sp)	8 July 86
39	Risdon Vale	Dry forest	6 June 87 (x)
40	Hobart, University	Wet forest (gully)	30 Sep 86, 23 Apr 87
41	South Arm Recreation Area	<i>Casuarina stricta</i>	12 June 86 (x), 18 July 86, 3 Sep 86
42A	South Arm Recreation Area	Tussocks grasses (<i>Poa</i> sp)	12 June 86, 18 July 86, 2 Oct 86, 5 June 87 (x)
42B	South Arm Recreation Area	Sedge	12 June 86, 18 July 86, 2 Oct 86, 3 Nov 86, 8 July 87
43A	South Arm Recreation Area	Bracken	12 June 86, 18 July 86, 3 Sep 86, 2 Oct 86, 3 Nov 86, 5 June 87, 8 July 87 (x)
43B	South Arm Recreation Area	<i>Exocarpus cupressiformis</i>	5 June 87
44	South Arm Recreation Area	Heath (mainly <i>Leptospermum</i>)	5 June 87
45	South Arm Recreation Area	<i>Dodonaea viscosa</i>	5 June 87, 8 July 87
46	South Arm Recreation Area	dead <i>Eucalyptus</i> foliage (dry forest)	3 Sep 86, 2 Oct 86, 3 Nov 86
47	South Arm Recreation Area	<i>Myoporum insulare</i>	3 Nov 86, 5 June 87
48	South Arm Recreation Area	<i>Acacia melanoxylon</i> (dry forest)	3 Nov 86
49	South Arm, Gellibrand Dve	dead <i>Melaleuca squarrosa</i>	18 July 86
50	Seven Mile Beach	<i>Pinus radiata</i>	8 June 87
51A	Seven Mile Beach	<i>Banksia marginata</i>	8 June 87
51B	Seven Mile Beach	<i>Casuarina stricta</i>	8 June 87 (x)
51C	Seven Mile Beach	<i>Dodonaea viscosa</i>	8 June 87
52A	Dodges Ferry	<i>Banksia marginata</i>	7 June 87
52B	Dodges Ferry	Tussock grasses (<i>Poa</i> sp)	7 June 87
52C	Dodges Ferry	Coastal scrub	7 June 87

Site	Locality	Vegetation	Date
53	Dodges Ferry	<i>Casuarina stricta</i>	7 June 87
54A	Tasman Peninsula, Gwondalon	Heath (mainly <i>Leptospermum</i>)	13 July 87 (x)
54B	Tasman Peninsula, Gwondalon	Tussock grasses (<i>Poa</i> sp)	13 July 87 (x)
55	Tasman Peninsula, Nubeena Rd	Heath (mainly <i>Leptospermum</i>)	18 Feb 88
56	Tasman Peninsula, Sth Nubeena	Heath (mainly <i>Leptospermum</i>)	13 July 87
57	Tasman Peninsula, Cape Raoul Tk	<i>Melaleuca squarrosa</i>	18 Feb 88
58	Tasman Peninsula, Cape Raoul	Heath (mainly <i>Leptospermum</i> and <i>Melaleuca</i>)	20 July 86
59A	Tasman Peninsula, Stewarts Bay Tk	<i>Acacia melanoxylon</i> (dry forest)	18 Feb 88
59B	Tasman Peninsula, Stewarts Bay Tk	Dry forest	18 Feb 88
59C	Tasman Peninsula, Stewarts Bay Tk	Dry forest	18 Feb 88
59D	Tasman Peninsula, Stewarts Bay	<i>Melaleuca squarrosa</i>	18 Feb 88
59E	Tasman Peninsula, Stewarts Bay	<i>Callitris rhomboidea</i>	18 Feb 88
60	Tasman Peninsula, Waterloo Bay	Wet/dry forest mosaic	18 Feb 88
61	Tasman Peninsula, West Eaglehawk Neck	<i>Acacia melanoxylon</i> (dry forest)	13 July 87
62	Tasman Peninsula, Eaglehawk Neck	<i>Melaleuca squarrosa</i>	13 July 87
63	Rheban	<i>Myoporum insulare</i>	30 Oct 86
64	Rheban	<i>Exocarpus cupressiformis</i>	30 Oct 86
65A	Rheban	Dry forest	19 Feb 88
65B	Rheban	Dry forest (dead foliage)	4 Sep 86, 19 Feb 88
66	Rheban	Dry forest (dead <i>Eucalyptus</i> foliage)	4 Sep 86, 30 Oct 86
67A	Sandspit Walking Tk	Wet forest	19 Feb 88
67B	Sandspit Walking Tk	Wet forest (dead foliage)	19 Feb 88
68A	Spring Beach	Coastal vegetation	19 Feb 88
68B	Spring Beach	<i>Callitris rhomboidea</i>	19 Feb 88
69	Tasman Hwy, Sth Orford	Dry forest	25 June 86
70	Tasman Hwy, Sth Orford	<i>Casuarina stricta</i>	3 June 86 (x), 25 June 86 (x)
71	Tasman Hwy, Nth Orford	Exotic Poplars	3 June 86 (x)
72	Tasman Hwy, Nth Orford	Exotic Hedge	3 June 86

Site	Locality	Vegetation	Date
73	Tunbridge - Steppes Rd	Tussock grasses (<i>Poa</i> sp)	25 Apr 87
74	Tunbridge - Steppes Rd	<i>Acacia melanoxylon</i> (wet forest)	29 May 86, 14 Aug 86, 13 Sep 86, 16 Oct 86, 13 Nov 86, 20 Jan 87, 9 Feb 87 (x), 18 Mar 87, 25 Apr 87, 31 May 87, 18 June 87, 31 July 87
75A	Tunbridge - Steppes Rd	<i>Bedfordia salicina</i>	29 May 86, 22 July 86, 14 Aug 86, 13 Sep 86, 16 Oct 86, 13 Nov 86, 20 Jan 87, 9 Feb 87, 18 Mar 87, 25 Apr 87, 31 May 87 (x), 18 June 87 (x), 31 July 87 (x)
75B	Tunbridge - Steppes Rd	<i>Bedfordia salicina</i>	29 May 86
76A	Tunbridge - Steppes Rd	<i>Acacia melanoxylon</i> (gully, dry forest)	29 May 86, 29 June 86, 22 July 86, 14 Aug 86, 13 Sep 86, 16 Oct 86, 13 Nov 86, 20 Jan 87, 9 Feb 87, 18 Mar 87, 25 Apr 87, 31 May 87, 18 June 87, 31 July 87 (x)
76B	Tunbridge - Steppes Rd	<i>Leptospermum lanigerum</i>	29 May 86 (x), 29 June 86 (x), 22 July 86 (x), 14 Aug 86 (x), 13 Sep 86 (x), 13 Nov 86 (x)
77	Lake Leake Rd	Dry forest	29 May 86, 29 June 86, 6 Aug 86 (x), 10 Sep 86 (x), 11 Oct 86, 5 Nov 86, 6 Dec 86, 17 Jan 87 (x), 4 Feb 87, 22 Mar 87, 22 Apr 87, 11 May 87, 12 June 87 (x), 24 July 87 (x), 21 Feb 88
78	Lake Leake Rd	dead <i>Eucalyptus</i> foliage (dry forest)	29 May 86
79	Freycinet NP, Brians Beach	dead <i>Myoporum insulare</i> foliage	3 Feb 87
80	Freycinet NP, Brians Beach	<i>Monotoca</i> sp	3 Feb 87
81	Freycinet NP, Mt Graham	dead dry forest vegetation	2 Feb 87
82	Freycinet NP, Mt Graham	<i>Leptospermum grandiflorum</i>	2 Feb 87
83A	Freycinet NP, Wineglass Bay	<i>Myoporum insulare</i>	2 Feb 87
83B	Freycinet NP, Wineglass Bay	<i>Monotoca</i> sp	11 June 87
83C	Freycinet NP, Wineglass Bay	<i>Casuarina stricta</i>	11 June 87 (x)
84	Freycinet NP, Hazards Beach - Wineglass Bay Tk	dead foliage (dry forest)	11 June 87
85	Freycinet NP, Hazards Beach Tk	dead <i>Casuarina</i> (dry forest)	16 May 86, 11 Sep 86, 10 Oct 86
86	Freycinet NP, Hazards Beach Tk	dead <i>Leptospermum</i> (dry forest)	16 May 86, 26 June 86, 10 Oct 86, 6 Nov 86, 21 Mar 87, 22 Apr 87, 10 June 87, 20 Feb 88
87	Freycinet NP, Hazards Beach Tk	<i>Letrospermum glaucescens</i>	16 May 86, 26 June 86, 7 Aug 86, 11 Sep 86 (x), 10 Oct 86 (x), 6 Nov 86 (x), 5 Dec 86, 16 Jan 87, 3 Feb 87, 21 Mar 87, 22 Apr 87, 11 May 87, 10 June 87, 23 July 87, 20 Feb 88
88A	Freycinet NP, Hazards Beach Tk	<i>Hakea epiglottis</i>	26 June 86, 7 Aug 86, 11 Sep 86, 10 Oct 86, 6 Nov 86, 5 Dec 86, 16 Jan 87, 3 Feb 87, 21 Mar 87, 22 Apr 87, 11 May 87, 10 June 87, 23 July 87, 20 Feb 88
88B	Freycinet NP, Hazards Beach Tk	<i>Kunzea ambigua</i>	16 May 86, 26 June 86, 7 Aug 86, 11 Sep 86 (x), 10 Oct 86, 6 Nov 86, 5 Dec 86, 16 Jan 87, 3 Feb 87, 21 Mar 87, 22 Apr 87, 11 May 87, 10

Site	Locality	Vegetation	Date
			June 87, 23 July 87, 20 Feb 88
88C	Freycinet NP, Hazards Beach Tk	dead <i>Kunzea ambigua</i>	10 Oct 86, 6 Nov 86
89	Freycinet NP, Hazards Beach Tk	<i>Acacia terminalis</i>	26 June 86, 21 Mar 87
90A	Freycinet NP, Honeymoon Bay	<i>Casuarina stricta</i>	16 May 86, 26 June 86, 7 Aug 86, 11 Sep 86, 10 Oct 86, 6 Nov 86 (x), 5 Dec 86, 17 Jan 87, 4 Feb 87, 21 Mar 87, 22 Apr 87, 11 May 87, 10 June 87, 23 July 87, 20 Feb 88
90B	Freycinet NP, Honeymoon Bay	<i>Monotoca</i> sp	22 Apr 87, 10 June 87, 23 July 87, 20 Feb 88
91	Freycinet NP, Mt Amos Tk	dead <i>Leptospermum</i> (dry forest)	26 May 86
92	Freycinet NP, Cape Tourville Rd	dead <i>Casuarina</i> (dry forest)	11 Sep 86, 23 July 87 (x)
93A	Freycinet NP, Rangers Creek	<i>Melaleuca squarrosa</i>	25 June 86 (x), 22 Apr 87, 11 May 87, 10 June 87, 23 July 87, 20 Feb 88
93B	Freycinet NP, nr Rangers Creek	dead <i>Eucalyptus</i> foliage (dry forest)	11 May 87
94	Cape Tourville Rd	<i>Callitris rhomboidea</i>	27 June 86, 7 Aug 86, 11 Sep 86 (x), 10 Oct 86, 6 Nov 86, 5 Dec 86, 16 Jan 87, 4 Feb 87, 21 Mar 87, 22 Apr 87, 11 May 87, 11 June 87, 23 July 87, 20 Feb 88
95A	Cape Tourville	<i>Leptospermum grandiflorum</i>	25 May 86 (x), 26 June 86, 7 Aug 86, 11 Sep 86, 10 Oct 86, 6 Nov 86 (x), 5 Dec 86, 16 Jan 87, 4 Feb 87, 21 Mar 87, 22 Apr 87, 11 May 87, 11 June 87, 23 July 87, 20 Feb 88
95B	Cape Tourville	dead <i>Leptospermum grandiflorum</i> foliage	26 June 86
96	Friendly Beaches	<i>Myoporum insulare</i>	6 Nov 86
97	Friendly Beaches	Heath (mainly <i>Leptospermum</i> and <i>Banksia</i>)	27 June 86, 8 Aug 86, 11 Sep 86 (x), 10 Oct 86 (x), 6 Nov 86, 21 Mar 87 (x), 22 Apr 87 (x), 11 May 87 (x), 11 June 87, 23 July 87 (x), 20 Feb 88
98	Friendly Beaches	dead foliage (mainly <i>Casuarina</i> , dry forest)	11 Sep 86, 10 Oct 86
99	Friendly Beaches	dead <i>Eucalyptus</i> foliage (dry forest)	10 Oct 86
100	Coles Bay Rd	Heath (mainly <i>Leptospermum</i>)	10 June 87
101	Apsley Gorge	dead material (dry forest)	21 Apr 87
102	Apsley Gorge	Wet/dry forest mosaic	29 June 86
103	Meetus Falls	Wet forest	21 Feb 88
104	Royal George, St Pauls River	<i>Callitris oblonga</i>	28 June 86, 8 Aug 86, 11 Sep 86 (x), 11 Oct 86, 7 Nov 86, 6 Dec 86, 17 Jan 87, 4 Feb 87, 22 Mar 87, 21 Apr 87, 11 May 87, 12 June 87, 24 July 87, 21 Feb 88
105	Avoca - Royal George Rd, St Pauls River	<i>Callitris oblonga</i>	3 June 86 (x)
106	Inland from Chain of Lagoons	Dry forest (mainly <i>Leptospermum</i>)	21 Apr 87
107	Chain of Lagoons	<i>Melaleuca ericifolia</i>	25 May 86, 27 June 86, 8 Aug 86, 12 Sep 86, 11 Oct 86, 7 Nov 86, 6 Dec 86, 17 Jan 87, 4 Feb

Site	Locality	Vegetation	Date
			87, 22 Mar 87, 21 Apr 87, 12 May 87, 12 June 87, 24 July 87, 22 Feb 88
108	Chain of Lagoons	<i>Myoporum insulare</i>	7 Nov 86
109A	Four Mile Creek	Tussock grasses (<i>Poa</i> sp)	12 June 87 (x)
109B	Four Mile Creek	Sedge	12 June 87 (x)
110	Falmouth	Heath (mainly <i>Leptospermum</i> and <i>Melaleuca</i>)	12 June 87 (x)
111A	Evercreech Forest Reserve	Wet forest	28 June 86, 13 Oct 86, 19 Jan 87 (x), 24 Mar 87, 20 Apr 87, 13 May 87 (x), 16 June 87
111B	Evercreech Forest Reserve	Mixed forest	28 June 86, 13 Oct 86, 11 Nov 86, 19 Jan 87, 24 Mar 87, 20 Apr 87, 13 May 87, 16 June 87 (x)
112	Evercreech Forest Reserve	Bracken	28 June 86 (x)
113	Evercreech Forest Reserve	<i>Exocarpus cupressiformis</i> (dry/wet forest mosaic)	28 June 86
114	Ben Lomond NP	<i>Acacia melanoxylon</i> (wet forest)	13 Oct 86
115A	Diddieum Plains	<i>Nothofagus cunninghamii</i>	9 Nov 86, 19 Jan 87, 6 Feb 87, 22 Feb 88
115B	Diddieum Plains	dead <i>Acacia dealbata</i> foliage	22 Feb 88
116	Cnr Mt Maurice and Ben Ridge Rds	<i>Leptospermum lanigerum</i>	22 Feb 88
117	Mt Maurice Rd	<i>Nothofagus cunninghamii</i>	10 Nov 86, 19 Jan 87
118	Mt Maurice Tk	<i>Nothofagus cunninghamii</i>	9 Nov 86, 6 Feb 87, 24 Mar 87, 13 May 87, 22 Feb 88
119A	Mt Maurice Tk	<i>Nothofagus cunninghamii</i> (mixed forest)	10 Nov 86, 19 Jan 87
119B	Mt Maurice Tk	dead <i>Eucalyptus</i> foliage (mixed forest)	24 Mar 87, 13 May 87 (x), 22 Feb 88
119C	Mt Maurice Tk	dead <i>Eucalyptus</i> foliage (mixed forest)	22 Feb 88
120	Mt Maurice Rd	<i>Nothofagus cunninghamii</i>	9 Nov 86
121A	Mt Maurice Rd	Wet forest	9 Nov 86, 19 Jan 87
121B	Mt Maurice Rd	Wet forest	19 Jan 87
122	Ben Ridge Rd	<i>Drimys lanceolata</i>	16 June 87 (x)
123	Cnr Ben Ridge and Telopea Rds	Rainforest	9 Nov 86, 24 Mar 87, 15 May 87
124A	Ben Ridge Rd	Tussock grasses (<i>Poa</i> sp)	16 June 87 (x)
124B	Ben Ridge Rd	Sedge	16 June 87 (x)
125	Ben Ridge Rd	<i>Nothofagus cunninghamii</i>	11 Nov 86, 6 Feb 87, 24 Mar 87, 20 Apr 87, 13 May 87, 16 June 87, 22 Feb 88
126	Ben Ridge Rd	<i>Melaleuca squarrosa</i>	6 Feb 87
127A	Ben Ridge Rd	dead scrub (mainly <i>Melaleuca</i> and <i>Leptospermum</i>)	6 Feb 87, 24 Mar 87, 20 Apr 87, 13 May 87, 16 June 87, 22 Feb 88
127B	Ben Ridge Rd	dead scrub (mainly <i>Melaleuca</i>)	6 Feb 87

Site	Locality	Vegetation	Date
128A	Ringarooma - Mathinna Rd	<i>Nothofagus cunninghamii</i>	13 Oct 86, 9 Nov 86, 19 Jan 87
128B	Ringarooma - Mathinna Rd	<i>Leptospermum lanigerum</i> (scrub)	9 Nov 86, 20 Apr 87
129	Mt Victoria Tk	Heath (mainly <i>Melaleuca</i>)	11 Nov 86, 6 Feb 87, 24 Mar 87, 20 Apr 87, 13 May 87, 16 June 87 (x)
130	St Columba Falls	Wet forest	11 July 86, 20 Apr 87
131A	St Helens Point	<i>Myoporum insulare</i>	24 Feb 88
131B	St Helens Point	<i>Casuarina stricta</i>	24 Feb 88 (x)
131C	St Helens Point	<i>Monotoca</i> sp	24 Feb 88
131D	St Helens Point	Tussock grasses (<i>Poa</i> sp)	24 Feb 88 (x)
131E	St Helens Point	<i>Casuarina littoralis</i>	24 Feb 88
131F	St Helens Point	<i>Melaleuca ericifolia</i>	24 Feb 88
132	Humbug Point	dead coastal vegetation	7 Nov 86
133	Humbug Point	<i>Melaleuca ericifolia</i>	11 Oct 86, 6 Dec 86, 22 Mar 87, 24 July 87
134	Humbug Point	<i>Acacia melanoxylon</i> (dry forest)	11 Oct 86
135	Humbug Point	Bracken	11 Oct 86
136	Humbug Point	Coastal vegetation	10 July 86
137A	Tasman Hwy	<i>Casuarina littoralis</i>	4 June 86, 11 July 86, 9 Aug 86, 12 Sep 86 (x), 12 Oct 86 (x), 8 Nov 86, 7 Dec 86 (x), 18 Jan 87 (x), 23 Mar 87, 20 Apr 87 (x), 12 May 87 (x), 14 June 87, 25 July 87, 24 Feb 88
137B	Tasman Hwy	dead foliage (<i>Leptospermum lanigerum</i>)	12 May 87
138	Ansons Bay Rd	Dry forest	12 June 87
139	Tasman Hwy	<i>Acacia melanoxylon</i> (swamp)	4 June 86, 11 July 86, 9 Aug 86, 12 Sep 86, 12 Oct 86, 8 Nov 86, 7 Dec 86, 18 Jan 87, 5 Feb 87, 23 Mar 87, 20 Apr 87, 12 May 87, 14 June 87, 25 July 87, 24 Feb 88
140	Tasman Hwy, near Myrtle Forest	<i>Acacia melanoxylon</i> (rainforest)	11 July 86, 9 Aug 86, 12 Sep 86, 12 Oct 86, 8 Nov 86, 7 Dec 86, 18 Jan 87 (x), 5 Feb 87, 20 Apr 87 (x), 12 May 87, 14 June 87 (x), 25 July 87 (x), 24 Feb 88
141	Tasman Hwy, near Myrtle Forest	<i>Nothofagus cunninghamii</i>	11 July 86 (x), 9 Aug 86, 12 Sep 86 (x), 12 Oct 86, 8 Nov 86, 7 Dec 86, 18 Jan 87, 5 Feb 87, 20 Apr 87, 12 May 87, 14 June 87, 25 July 87 (x), 24 Feb 88
142A	Myrtle Forest	<i>Nothofagus cunninghamii</i>	4 June 86, 12 May 87, 24 Feb 88
142B	Myrtle Forest	<i>Acacia melanoxylon</i> (rainforest)	4 June 86, 14 June 87,
142C	Myrtle Forest	dead treefern foliage	24 Feb 88
143	Tasman Hwy	Wet forest	4 June 86, 5 Feb 87 (x)
144	Herrick	Heath (mainly <i>Leptospermum</i>)	12 May 87, 24 Feb 88
145	Ansons Bay Rd	Dry forest	13 June 87 (x)

Site	Locality	Vegetation	Date
146	Eddystone Point Rd	Dry forest	23 Feb 88
147	Eddystone Point Rd	Dry forest	23 Feb 88
148	Eddystone Point Rd	Dry forest	13 June 87, 23 Feb 88
149A	Eddystone Point Rd	<i>Melaleuca squarrosa</i>	13 June 87
149B	Eddystone Point Rd	<i>Melaleuca ericifolia</i>	13 June 87
150	Eddystone Point Rd	<i>Leptospermum lanigerum</i>	13 June 87, 26 July 87, 23 Feb 88
151	Eddystone Point Rd	dead heath (mainly <i>Melaleuca</i>)	13 June 87, 26 July 87
152A	Eddystone Point	<i>Casuarina stricta</i>	13 June 87, 26 July 87, 23 Feb 88
152B	Eddystone Point	<i>Monotoca</i> sp	13 June 87, 26 July 87, 23 Feb 88
152C	Eddystone Point	<i>Myoporum insulare</i>	13 June 87, 26 July 87, 23 Feb 88
152D	Eddystone Point	<i>Acacia</i> sp (?)	13 June 87
152E	Eddystone Point	Heath (mainly <i>Casuarina</i>)	13 June 87, 26 July 87
152F	Eddystone Point	Tussock grasses (<i>Poa</i> sp)	26 July 87 (x)
153	Mt William NP, Mt William Summit	Heath/scrub mosaic (mainly <i>Kunzea</i>)	23 Feb 88
154	Mt William NP, Mt William Walking Tk	Dry forest	23 Feb 88
155	Mt William NP, Mt William Car Park	Heath (mainly <i>Kunzea</i>)	23 Feb 88
156	Mt William NP, Loop	dead Heath (<i>Leptospermum</i>)	5 Feb 87, 23 Mar 87, 19 Apr 87, 14 June 87, 23 Feb 88
157	Mt William NP, Loop	Dry woodland (mainly <i>Kunzea</i>)	5 June 86 (x), 11 July 86, 9 Aug 86, 12 Sep 86, 12 Oct 86 (x), 8 Nov 86 (x), 7 Dec 86, 18 Jan 87, 5 Feb 87 (x), 23 Mar 87, 19 Apr 87, 12 May 87, 14 June 87, 25 July 87, 23 Feb 88
158	Mt William NP, Loop	Sedge	5 June 86, 11 July 86, 9 Aug 86, 12 Sep 86, 12 Oct 86, 8 Nov 86, 7 Dec 86, 18 Jan 87, 5 Feb 87, 23 Mar 87, 19 Apr 87, 12 May 87 (x), 14 June 87, 25 July 87, 23 Feb 88
159A	Mt William NP, Stumpys Bay	<i>Casuarina stricta</i>	5 June 86, 11 July 86, 9 Aug 86, 12 Sep 86, 12 Oct 86, 8 Nov 86, 7 Dec 86, 18 Jan 87, 5 Feb 87, 23 Mar 87, 19 Apr 87, 12 May 87, 14 June 87, 25 July 87, 23 Feb 88
159B	Mt William NP, Stumpys Bay	<i>Myoporum insulare</i>	12 Oct 86, 8 Nov 86, 7 Dec 86, 18 Jan 87, 5 Feb 87, 23 Mar 87, 19 Apr 87, 25 July 87, 23 Feb 88
159C	Mt William NP, Stumpys Bay	<i>Monotoca</i> sp	12 Oct 86, 7 Dec 86, 19 Apr 87, 12 May 87, 23 Feb 88
159D	Mt William NP, Stumpys Bay	dead foliage (<i>Casuarina</i> and <i>Myoporum</i>)	8 Nov 86, 5 Feb 87
160	Mt William NP, Loop	Heath (mainly <i>Casuarina</i>)	5 June 86, 11 July 86, 9 Aug 86 (x), 12 Sep 86, 12 Oct 86, 8 Nov 86 (x), 7 Dec 86 (x), 18 Jan 87 (x), 5 Feb 87, 23 Mar 87, 19 Apr 87, 12 May 87, 14 June 87, 25 July 87 (x), 23 Feb 88
161	Mt William NP, Loop	Heath (mainly <i>Leptospermum</i>)	19 Apr 87

Site	Locality	Vegetation	Date
162	Poole	<i>Leptospermum laevigatum</i>	5 June 86 (x), 11 July 86 (x), 9 Aug 86, 12 Sep 86, 12 Oct 86 (x), 8 Nov 86 (x), 7 Dec 86, 18 Jan 87, 23 Mar 87, 19 Apr 87, 12 May 87, 14 June 87, 25 July 87, 23 Feb 88
163	Gladstone - Bridport Rd	Heath (mainly <i>Leptospermum</i> and <i>Casuarina</i>)	19 Apr 87, 12 May 87, 14 June 87, 26 July 87, 24 Feb 88
164A	Blackmans Lagoon	exotic Cypress trees	5 June 86
164B	Blackmans Lagoon	<i>Myoporum insulare</i>	5 June 86, 9 Aug 86, 12 Sep 86, 12 Oct 86, 8 Nov 86, 7 Dec 86, 18 Jan 87, 5 Feb 87, 23 Mar 87, 19 Apr 87, 12 May 87, 14 June 87, 26 July 87, 24 Feb 88
165	Bridport	Coastal vegetation	26 July 87
166	Bridport	<i>Casuarina stricta</i>	26 July 87
167	Tasman Hwy	Wet forest	5 June 86, 10 Aug 86, 12 Sep 86, 12 Oct 86 (x), 7 Dec 86 (x)

Site	Locality	Vegetation	Date
168	Tunbridge - Steppes Rd	<i>Leptospermum lanigerum</i>	29 May 86, 13 Sep 86, 16 Oct 86, 20 Jan 87 (x), 9 Feb 87 (x), 18 Mar 87 (x), 25 Apr 87, 31 May 87, 18 June 87 (x), 31 July 87 (x)
169	Lake Hwy	<i>Arthrotaxis cupressoides</i>	30 May 86 (x), 13 Sep 86 (x), 13 Nov 86, 20 Jan 87 (x), 9 Feb 87 (x), 18 Mar 87, 25 Apr 87, 31 May 87 (x), 18 June 87 (x), 31 July 87 (x)
170	Lake Hwy	<i>Nothofagus cunninghamii</i>	13 Nov 86
171	Lake Hwy, Lkt near Projection Bluff	Wet woodland	25 Apr 87
172	Lake Hwy	<i>Nothofagus cunninghamii</i>	30 May 86, 10 Aug 86 (x), 13 Sep 86 (x), 13 Nov 86, 20 Jan 87, 9 Feb 87, 18 Mar 87, 25 Apr 87, 31 May 87 (x), 18 June 87 (x), 31 July 87 (x), 26 Feb 88
173	Lake Hwy	<i>Pinus radiata</i>	30 May 86
174	Liffey Falls	<i>Nothofagus cunninghamii</i>	26 Feb 88
175	Lake Hwy	<i>Nothofagus cunninghamii</i>	30 May 86, 12 July 86, 10 Aug 86, 13 Sep 86 (x), 14 Oct 86 (x), 13 Nov 86, 20 Jan 87, 9 Feb 87, 18 Mar 87, 26 Apr 87, 31 May 87, 18 June 87 (x), 31 July 87 (x), 26 Feb 88
176	Lake Hwy	Wet forest	13 Nov 86
177	Lake Hwy	Wet forest	30 May 86, 12 July 86, 10 Aug 86, 13 Sep 86, 14 Oct 86, 13 Nov 86, 20 Jan 87, 9 Feb 87, 18 Mar 87, 26 Apr 87, 31 May 87, 18 June 87, 31 July 87, 26 Feb 88
178A	Jackeys Marsh (east)	Bracken	12 Nov 86
178B	Jackeys Marsh (east)	<i>Carex appressa</i>	12 Nov 86
179A	Jackeys Marsh (east)	Wet forest (dead foliage)	18 Mar 87, 26 Feb 88
179B	Jackeys Marsh (east)	Wet forest (dead foliage)	26 Feb 88
180A	Jackeys Marsh (east)	Wet forest	13 Nov 86, 8 Dec 86, 20 Jan 87, 18 Mar 87, 1 June 87, 31 July 87, 26 Feb 88
180B	Jackeys Marsh (east)	<i>Nothofagus cunninghamii</i> (mixed forest)	13 Nov 86, 8 Dec 86, 20 Jan 87, 18 Mar 87, 1 June 87, 31 July 87, 26 Feb 88
181	Lake Hwy	<i>Exocarpus cupressiformis</i> (wet/dry forest mosaic)	30 May 86, 12 July 86 (x), 10 Aug 86 (x), 13 Sep 86, 14 Oct 86, 13 Nov 86, 20 Jan 87, 9 Feb 87, 18 Mar 87, 26 Apr 87, 31 May 87, 18 June 87, 31 July 87, 26 Feb 88
182	Launceston, Cataract Gorge	<i>Acacia melanoxylon</i> (dry forest)	22 July 86, 11 Nov 86, 15 June 87

Site	Locality	Vegetation	Date
183	Launceston, Cataract Gorge	<i>Casuarina stricta</i> (dead foliage)	22 July 86, 11 Nov 86, 17 June 87
184	Launceston, Cataract Gorge	Exotic vegetation	27 Aug 86, 11 Nov 86, 15 June 87
185	Launceston, Cataract Gorge	Tussock grasses (<i>Poa</i> sp)	22 July 86, 15 June 87, 17 June 87
186	Notley Gorge	Wet forest	27 July 87
187	Bell Bay	Dry forest	15 June 87 (x)
188	Low Head, Eastern Beach	<i>Acacia melanoxylon</i> (planted alongside of road)	15 June 87
189	Low Head, Eastern Beach	<i>Melaleuca ericifolia</i>	15 June 87
190	Low Head, Eastern Beach	<i>Acacia</i> sp (?)	15 June 87
191	Greens Beach	<i>Melaleuca ericifolia</i>	15 June 87
192	Greens Beach	<i>Myoporum insulare</i>	15 June 87
193A	Asbestos Range NP	<i>Banksia marginata</i>	17 June 87, 27 July 87, 25 Feb 88
193B	Asbestos Range NP	<i>Casuarina stricta</i>	17 June 87, 27 July 87, 25 Feb 88
193C	Asbestos Range NP	Bracken	17 June 87, 27 July 87, 25 Feb 88 (x)
194A	Asbestos Range NP	Heath (mainly <i>Leptospermum scoparium</i>)	17 June 87, 27 July 87, 25 Feb 88
194B	Asbestos Range NP	<i>Melaleuca ericifolia</i>	17 June 87, 27 July 87, 25 Feb 88
195	Asbestos Range NP	<i>Acacia melanoxylon</i> (dry forest)	17 June 87, 25 Feb 88 (x)
196	Asbestos Range NP	<i>Myoporum insulare</i>	6 June 86, 17 June 87, 25 Feb 88 (x)
197	Asbestos Range NP Rd	<i>Leptospermum</i> scrub	25 Feb 88
198	Frankford Main Rd	<i>Casuarina littoralis</i>	25 Feb 88
199	Frankford Main Rd	Wet/dry forest mosaic	25 Feb 88
200A	Bass Hwy	<i>Melaleuca ericifolia</i> (understorey in wet/dry forest mosaic)	18 Apr 87
200B	Bass Hwy	<i>Exocarpus cupressiformis</i>	18 Apr 87
200C	Bass Hwy	<i>Melaleuca ericifolia</i> (understorey in dry/west forest mosaic)	18 Apr 87
201	Bass Hwy	dead <i>Eucalyptus</i> foliage (wet/dry forest mosaic)	18 Apr 87
202	Bass Hwy	Wet/dry forest mosaic (mainly <i>Leptospermum</i> heath understorey)	18 Apr 87
203A	Bass Hwy	<i>Myoporum insulare</i>	24 Jan 87
203B	Bass Hwy	dead <i>Myoporum</i> foliage	24 Jan 87
204	Bass Hwy	<i>Melaleuca ericifolia</i>	25 June 87 (x)
205	Forth - Wilmot Rd	Wet/dry forest mosaic	8 June 86, 12 July 86 (x), 25 Mar 87

Site	Locality	Vegetation	Date
206	Spellmens Gorge	Wet forest	26 July 86
207	Leven Canyon Lkt	<i>Leptospermum scoparium</i> (low wet/dry mosaic)	17 Apr 87, 20 May 87, 29 June 87, 28 Feb 88
208	Leven Canyon Tk	Tall scrub	17 Apr 87
209	Leven Canyon	<i>Callistemon</i> sp.	17 Apr 87, 20 May 87, 29 June 87 (x), 28 Feb 88
210	Bell Mtn	Wet forest (heath understorey)	1 June 87
211	Cnr Mole Creek and Wilmot - Sheffield Rds	Wet forest (heath understorey)	27 Jan 87
212	Garrie Park	Wet forest (heath understorey)	27 Feb 88
213	Garrie Park	Wet forest (heath understorey)	1 June 87 (x), 27 Feb 88
214A	Wilmot - Cradle Mtn Rd	dead rainforest foliage	2 Mar 87, 17 Mar 87, 16 Apr 87, 19 May 87, 29 June 87, 28 Feb 88
214B	Wilmot - Cradle Mtn Rd	Tussock grasses (<i>Poa</i> sp)	19 May 87 (x)
215	Daisy Dell	<i>Nothofagus cunninghamii</i>	6 June 86, 12 July 86, 30 Aug 86 (x), 29 Sep 86, 26 Oct 86, 26 Nov 86, 23 Jan 87, 7 Feb 87, 2 Mar 87, 17 Mar 87, 16 Apr 87, 19 May 87, 29 June 87, 28 Feb 88
216A	Pencil Pine Inn	<i>Nothofagus cunninghamii</i>	26 Nov 86, 2 Mar 87
216B	Pencil Pine Inn	<i>Athrotaxis cupressoides</i>	26 Nov 86, 2 Mar 87
216C	Pencil Pine Inn	<i>Richea pandanifolia</i>	26 Nov 86
216D	Pencil Pine Inn	dead <i>Eucalyptus</i> foliage (wet forest)	16 Apr 87
217	Cradle Mtn Rd	<i>Nothofagus cunninghamii</i>	26 Nov 86, 19 May 87
218	Cradle Mtn - Lake St Clair NP, Camping Area	<i>Athrotaxis cupressoides</i>	27 Nov 86, 23 Jan 87, 17 Mar 87, 16 Apr 87, 19 May 87, 28 Feb 88
219A	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Nothofagus cunninghamii</i>	26 Oct 86, 26 Nov 86, 7 Feb 87, 2 Mar 87, 17 Mar 87, 28 Feb 88
219B	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Richea scoparia</i>	26 Oct 86, 26 Nov 86, 23 Jan 87 (x)
219C	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Athrotaxis selaginoides</i>	26 Oct 86, 26 Nov 86, 7 Feb 87, 28 Feb 88
219D	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Phyllocladus aspleniifolius</i>	26 Oct 86, 27 Nov 86, 23 Jan 87, 7 Feb 87, 2 Mar 87, 17 Mar 87, 16 Apr 87, 19 May 87, 30 July 87 (x), 28 Feb 88
219E	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Nothofagus cunninghamii</i>	26 Nov 86, 23 Jan 87, 2 Mar 87, 16 Apr 87, 19 May 87, 30 July 87 (x), 28 Feb 88
219F	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Athrotaxis selaginoides</i>	27 Nov 86, 23 Jan 87, 7 Feb 87, 2 Mar 87, 17 Mar 87, 16 Apr 87, 19 May 87

Site	Locality	Vegetation	Date
219G	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Nothofagus gunnii</i>	27 Nov 86, 23 Jan 87, 2 Mar 87
219H	Cradle Mtn - Lake St Clair NP, Weindorfers Forest	<i>Leptospermum lanigerum</i>	23 Jan 87, 2 Mar 87, 17 Mar 87, 16 Apr 87, 19 May 87 (x), 28 Feb 88
220	Cradle Mtn - Lake St Clair NP, Dove Lake	Heath	27 Nov 86, 17 Mar 87 (x), 16 Apr 87 (x)
221	Cradle Mtn - Lake St Clair NP, Dove Lake	<i>Diselma archeri</i>	27 Nov 86, 23 Jan 87, 16 Apr 87, 19 May 87
222	Cradle Mtn - Lake St Clair NP, Ballroom Forest	Rainforest	7 June 86, 26 Oct 86, 27 Nov 86, 23 Jan 87
223	Cradle Mtn - Lake St Clair NP, Marions Lkt	<i>Diselma archeri</i>	23 Jan 87 (x)
224A	Emu Plains	<i>Leptospermum lanigerum</i>	27 Feb 88
224B	Emu Plains	<i>Drimys lanceolata</i>	27 Feb 88
225A	Cradle Mtn - Lake St Clair NP, Overland Tk, Cirque Hut	<i>Athrotaxis cupressoides</i>	4 Mar 87
225B	Cradle Mtn - Lake St Clair NP, Overland Tk, Cirque Hut	<i>Leptospermum lanigerum</i>	4 Mar 87
225C	Cradle Mtn - Lake St Clair NP, Overland Tk, Cirque Hut	<i>Nothofagus cunninghamii</i>	4 Mar 87
225D	Cradle Mtn - Lake St Clair NP, Overland Tk, Cirque Hut	dead heath (mainly <i>Leptospermum</i>)	4 Mar 87
226A	Cradle Mtn - Lake St Clair NP, Overland Tk, Windermere Hut	<i>Nothofagus cunninghamii</i>	5 Mar 88
226B	Cradle Mtn - Lake St Clair NP, Overland Tk, Windermere Hut	dead rainforest foliage	5 Mar 88
226C	Cradle Mtn - Lake St Clair NP, Overland Tk, Windermere Hut	dead rainforest foliage	5 Mar 88
227A	Cradle Mtn - Lake St Clair NP, Overland Tk, Du Cane Hut	<i>Leptospermum lanigerum</i>	10 Mar 87
227B	Cradle Mtn - Lake St Clair NP, Overland Tk, Du Cane Hut	<i>Nothofagus cunninghamii</i>	10 Mar 87
228	Cradle Mtn - Lake St Clair NP, Overland Tk	Rainforest	15 Sep 86
229	Cradle Mtn - Lake St Clair NP, Lake St Clair	<i>Nothofagus cunninghamii</i>	1 Dec 86, 27 Jan 87 (x), 27 Feb 87, 29 Apr 87, 1 July 87, 10 Mar 88
230A	Cradle Mtn - Lake St Clair NP, Lake St Clair	<i>Nothofagus cunninghamii</i>	31 May 86 (x), 1 July 86 (x), 12 Aug 86 (x), 15 Sep 86 (x), 16 Oct 86 (x), 16 Nov 86 (x), 1 Dec 86, 1 July 87 (x)
230B	Cradle Mtn - Lake St Clair NP, Lake St Clair	<i>Phyllocladus aspleniifolius</i>	31 May 86, 1 July 86 (x), 12 Aug 86 (x), 15 Sep 86, 16 Oct 86 (x), 16 Nov 86, 1 Dec 86, 27 Jan 87 (x), 27 Feb 87 (x), 29 Apr 87 (x), 1 July 87 (x), 10 Mar 88
231	Cradle Mtn - Lake St Clair NP, end of Watersmeet Tk	dead <i>Leptospermum</i> foliage (rainforest)	31 May 86, 16 Nov 86, 29 Apr 87, 10 Mar 88

Site	Locality	Vegetation	Date
232	Cradle Mtn - Lake St Clair NP, Watersmeet Tk	dead <i>Leptospermum</i> foliage (wet forest)	31 May 86
233	Lyell Hwy	<i>Nothofagus cunninghamii</i> (mixed forest)	31 May 86, 13 June 86, 1 July 86 (x), 30 Nov 86 (x)
234	Lyell Hwy	<i>Nothofagus cunninghamii</i>	30 Nov 86, 29 Apr 87, 9 Mar 88
235	Lyell Hwy	<i>Nothofagus cunninghamii</i>	30 Nov 86
236	Lyell Hwy, Frenchmans Cap NP, Start of Walking Tk	Heath	29 Apr 87
237	Lyell Hwy, Wild Rivers NP	Heath	29 Apr 87
238	Frenchmans Cap NP, Philps Creek	Wet Scrub	9 Mar 88
239	Frenchmans Cap NP, Lake Vera	Wet Scrub	8 Mar 88
240	Frenchmans Cap NP Walking Tk	Rainforest	9 Mar 88 (x)
241	Frenchmans Cap NP, Tahune Lake	Rainforest	7 Mar 88
242	Lyell Hwy	<i>Hakea epiglottis</i>	3 July 86, 12 Aug 86, 15 Sep 86 (x), 16 Oct 86, 16 Nov 86, 27 Jan 87, 27 Feb 87, 29 Apr 87, 1 July 87 (x), 10 Mar 88
243	Tarraleah	Bracken	31 May 86, 1 July 86, 12 Aug 86, 15 Sep 86, 16 Oct 86, 16 Nov 86, 1 Dec 86, 27 Jan 87 (x), 27 Feb 87, 29 Apr 87, 1 July 87 (x), 10 Mar 88 (x)
244A	Lyell Hwy	<i>Atherosperma moschatum</i>	16 Nov 86
244B	Lyell Hwy	Wet forest	16 Nov 86 (x)
244C	Lyell Hwy	<i>Nothofagus cunninghamii</i>	16 Nov 86, 1 Dec 86

Site	Locality	Vegetation	Date
245	Rocky Cape NP, Postmans Tk Car Park	Wet scrub (mainly <i>Leptospermum scoparium</i> and <i>Melaleuca squarrosa</i>)	26 Apr 87, 3 Mar 88
246	Rocky Cape NP, Sisters Beach Rd	Heath/wet scrub (mainly <i>Leptospermum scoparium</i> and <i>Melaleuca squarrosa</i>)	14 June 86, 25 July 86, 23 Sep 86, 25 Oct 86, 24 Nov 86, 24 Jan 87, 1 Mar 87, 26 Mar 87, 26 Apr 87, 23 May 87, 28 June 87, 30 July 87, 3 Mar 88
247A	Sisters Beach	dead <i>Banksia serrata</i> foliage	26 Apr 87, 29 Feb 88
247B	Sisters Beach	dead <i>Eucalyptus</i> foliage (dry forest)	26 Apr 87
248A	Sisters Beach	<i>Banksia serrata</i>	14 June 86, 25 July 86, 24 Aug 86, 23 Sep 86, 25 Oct 86, 24 Nov 86, 9 Dec 86 (x), 24 Jan 87, 1 Mar 87, 26 Mar 87, 26 Apr 87, 23 May 87, 28 June 87, 30 July 87, 29 Feb 88
248B	Sisters Beach	Bracken	14 June 86, 25 July 86, 24 Aug 86, 23 Sep 86, 25 Oct 86, 24 Nov 86, 9 Dec 86, 24 Jan 87 (x), 1 Mar 87, 26 Mar 87, 26 Apr 87, 23 May 87, 28 June 87, 30 July 87, 29 Feb 88
249	Sisters Beach	<i>Myoporum insulare</i>	23 Oct 86
250	Rocky Cape NP, Banksia Grove Tk	Heath (mainly <i>Leptospermum</i> and <i>Casuarina</i>)	24 Aug 86
251	Rocky Cape NP, Banksia Grove Tk	Low <i>Eucalyptus</i> woodland (heath understorey)	24 Jan 87
252A	Rocky Cape NP, Banksia Grove	<i>Banksia serrata</i>	24 Jan 87, 1 Mar 87, 26 Mar 87, 26 Apr 87, 23 May 87, 28 June 87, 30 July 87, 29 Feb 88
252B	Rocky Cape NP, Banksia Grove	<i>Banksia</i> woodland (heath understorey)	24 Jan 87, 1 Mar 87, 26 Mar 87, 26 Apr 87, 23 May 87, 28 June 87 (x), 30 July 87, 29 Feb 88
253	Detention Falls	Wet/dry forest mosaic	23 Oct 86
254	Rocky Cape NP, Rocky Cape Rd	Heath (mainly <i>Leptospermum</i>)	23 Oct 86, 26 Jan 87 (sweep), 29 July 87
255	Port Latta	Dry forest (heath/scrub understorey)	27 June 87
256	Smithton	Heath (mainly <i>Leptospermum</i>)	27 Apr 87, 21 May 87, 26 June 87, 28 July 87 (x)
257	Brittons Swamp	<i>Acacia melanoxylon</i>	15 June 86, 25 July 86, 28 Aug 86, 22 Sep 86, 25 Oct 86, 24 Nov 86
258	Bass Hwy	Wet forest	15 June 86, 25 July 86, 28 Aug 86 (x), 22 Sep 86, 25 Oct 86, 24 Nov 86, 25 Jan 87, 26 Mar 87, 27 Apr 87, 21 May 87, 26 June 87, 28 July 87, 1 Mar 88
259	Marrawah - Arthur River Rd	<i>Acacia melanoxylon</i> (swamp)	22 Sep 86, 25 Oct 86, 24 Nov 86, 25

Site	Locality	Vegetation	Date
		forest)	Jan 87, 1 Mar 87, 26 Mar 87, 27 Apr 87, 25 May 87, 26 June 87, 28 July 87, 1 Mar 88
260	Marawah - Arthur River Rd	Dry woodland	24 Nov 86
261A	Arthur River	<i>Myoporum insulare</i>	15 June 86, 24 July 86, 28 Aug 86, 22 Sep 86, 25 Oct 86, 24 Nov 86, 25 Jan 87, 1 Mar 87, 26 Mar 87, 27 Apr 87, 21 May 87, 26 June 87, 28 July 87, 1 Mar 88
261B	Arthur River	<i>Leptospermum laevigatum</i>	15 June 86, 24 July 86 (x), 28 Aug 86 (x), 22 Sep 86 (x), 25 Oct 86, 24 Nov 86, 25 Jan 87, 1 Mar 87, 26 Mar 87, 27 Apr 87, 21 May 87, 26 June 87 (x), 28 July 87 (x), 1 Mar 88
261C	Arthur River	<i>Leptospermum lanigerum</i>	15 June 86, 24 July 87, 28 Aug 86 (x), 22 Sep 86, 25 Oct 86, 24 Nov 86, 25 Jan 87, 1 Mar 87, 26 Mar 87, 27 Apr 87, 21 May 87, 26 June 87, 28 July 87, 1 Mar 88
262A	Temma - Arthur River Rd	<i>Melaleuca ericifolia</i>	15 June 86, 24 July 86 (x), 28 Aug 86, 22 Sep 86, 25 Oct 86, 24 Nov 86, 25 Jan 87, 1 Mar 87, 26 Mar 87, 27 Apr 87, 21 May 87, 26 June 87, 28 July 87, 1 Mar 88
262B	Temma - Arthur River Rd	<i>Leptospermum laevigatum</i>	26 June 87
263	Temma - Arthur River Rd	<i>Melaleuca ericifolia</i>	28 Aug 86 (x), 25 Jan 87, 1 Mar 87, 26 Mar 87, 21 May 87, 26 June 87, 28 July 87, 1 Mar 88
264A	Temma - Arthur River Rd	dead <i>Eucalyptus</i> foliage (dry woodland)	28 Aug 86, 22 Sep 86
264B	Temma - Arthur River Rd	Heath (mainly <i>Leptospermum</i>)	22 Sep 86, 25 Jan 87 (sweeping), 21 May 87
265A	Temma - Arthur River Rd	Heath (mainly <i>Leptospermum</i> and <i>Casuarina</i>)	15 June 86, 24 July 86, 28 Aug 86, 22 Sep 86, 25 Oct 86, 24 Nov 86, 25 Jan 87, 1 Mar 87, 26 Mar 87, 27 Apr 87, 21 May 87, 26 June 87, 28 July 87, 1 Mar 88
265B	Temma - Arthur River Rd	Heath	25 Jan 87 (sweeping)
266	Temma - Arthur River Rd	<i>Melaleuca squarrosa</i>	28 Aug 86
267	Rebecca Rd	Mixed forest (mainly dead rainforest foliage)	1 Mar 88
268	Rebecca Rd	Mixed forest (mainly dead rainforest foliage)	1 Mar 88
269	Sumac Rd	Mixed forest (mainly dead rainforest foliage)	1 Mar 88
270	Sumac Rd, Frankland River	Rainforest shrubs	2 Mar 88
271	Sumac Rd	dead Heath (<i>Leptospermum</i>)	2 Mar 88

Site	Locality	Vegetation	Date
272	Balfour Tk	Rainforest	2 Mar 88
273	Roger River West Rd	Heath (mainly <i>Melaleuca</i>)	22 May 87
274	Kanunah Bridge	<i>Acacia melanoxylon</i> (rainforest)	29 Aug 86, 23 Sep 86, 24 Oct 86 (x), 25 Nov 86, 9 Dec 86, 26 Jan 87, 28 Feb 87, 25 Mar 87, 22 May 87, 29 July 87, 2 Mar 88
275	Sumac Rd	<i>Nothofagus cunninghamii</i>	29 Aug 86, 23 Sep 86, 24 Oct 86, 25 Nov 86, 9 Dec 86 (x), 26 Jan 87, 28 Feb 87, 25 Mar 87, 27 Apr 87 (x), 22 May 87, 29 July 87, 2 Mar 88
276	Julius River Forest Reserve	<i>Nothofagus cunninghamii</i>	29 Aug 86, 23 Sep 86, 24 Oct 86, 25 Nov 86 (x), 9 Dec 86, 26 Jan 87, 28 Feb 87, 25 Mar 87, 27 Apr 87 (x), 22 May 87, 29 July 87, 2 Mar 88
277	Lake Chisolm	Rainforest	29 Aug 86, 2 Mar 88
278A	Rapid River Rd	dead <i>Eucalyptus</i> foliage (mixed forest)	25 Mar 87, 22 May 87
278B	Rapid River Rd	dead <i>Nothofagus</i> foliage (mixed forest)	25 Mar 87
279	Rapid River Rd	Heath (mainly <i>Leptospermum</i> and <i>Melaleuca</i>)	26 Jan 87 (sweep), 28 Feb 87, 25 Mar 87, 22 May 87, 2 Mar 88
280A	Milkshakes Forest Reserve	<i>Nothofagus cunninghamii</i> (mixed forest)	14 June 86, 25 July 86 (x), 29 Aug 86, 23 Sep 86, 24 Oct 86, 25 Nov 86, 9 Dec 86, 26 Jan 87, 28 Feb 87, 25 Mar 87, 24 Apr 87, 22 May 87, 29 July 87, 2 Mar 88 (x)
280B	Milkshakes Forest Reserve Rd	Heath	22 May 87
281	Trowutta Rd, Pine Tk	Rainforest	14 June 86, 25 July 86 (x), 23 Sep 86, 24 Oct 86, 25 Nov 86, 9 Dec 86, 26 Jan 87, 28 Feb 87, 25 Mar 87, 27 Apr 87, 22 May 87, 29 July 87 (x), 2 Mar 88
282A	Roger River West	<i>Nothofagus cunninghamii</i>	29 Aug 86 (x)
282B	Roger River West	<i>Acacia melanoxylon</i> (rainforest)	29 Aug 86 (x)
282C	Roger River West	Wet forest	29 Aug 86 (x)
283	Roger River	Wet forest	14 June 86
284	Murchison Hwy	dead foliage (wet scrub)	27 Mar 87
285A	Hellyer Gorge	Wet forest	28 Nov 86
285B	Hellyer Gorge	<i>Nothofagus cunninghamii</i>	27 Mar 87, 2 June 87, 3 Mar 88
285C	Hellyer Gorge	dead rainforest foliage	27 Mar 87, 3 Mar 88
285D	Hellyer Gorge	Rainforest (mainly <i>Eucryphia</i>)	27 Mar 87
285E	Hellyer Gorge	Rainforest (mainly <i>Nothofagus</i>)	28 Nov 86, 27 Mar 87, 3 Mar 88

Site	Locality	Vegetation	Date
286	Murchison Hwy	Tussock grasses (<i>Poa</i> sp)	27 Mar 87
287	Murchison Hwy	<i>Acacia melanoxylon</i> (tall woodland)	28 Nov 86
288	Savage River Rd	dead rainforest foliage	27 Mar 87
289	Murchison Hwy, Rest Stop	Rainforest	28 Apr 87, 4 Mar 88
290A	Staffords Rd	Mixed forest	28 Apr 87
290B	Staffords Rd	Rainforest	2 June 87
291	Savage River Rd	<i>Nothofagus cunninghamii</i>	4 Mar 88
292	Savage River Rd	<i>Nothofagus cunninghamii</i>	28 Nov 86
293	Corinna Rd	dead <i>Leptospermum</i> foliage	27 Mar 87
294A	Corinna, Pieman River	<i>Nothofagus cunninghamii</i>	28 Nov 86, 27 Mar 87
294B	Corinna, Whyte River Tk	Rainforest	28 Nov 86, 27 Mar 87, 4 Mar 88
294C	Corinna, Whyte River Tk	<i>Acacia melanoxylon</i>	28 Nov 86, 27 Mar 87
295	Pieman Dam Rd	Heath	28 Apr 87
296	Pieman Dam Rd	dead foliage (heath)	28 Apr 87
297	Pieman Dam Rd	Heath	28 Apr 87 (x)
298	Pieman Dam Rd	Wet forest	28 Mar 87
299	Pieman Dam Rd	<i>Nothofagus cunninghamii</i>	29 Nov 86, 28 Mar 87
300	Pieman Dam Rd	<i>Eucalyptus</i> woodland	29 Nov 86 (x), 28 Mar 87
301	Pieman Dam Rd	Heath	28 Apr 87 (x)
302	Murchison Hwy, N Tullah	Wet forest (<i>Leptospermum</i> heath understorey)	28 Mar 87, 28 Apr 87, 2 June 87 (x), 4 Mar 88
303	Murchison Hwy, S Tullah	Wet scrub (<i>Leptospermum</i> and <i>Melaleuca</i>)	28 Mar 87, 28 Apr 87, 2 June 87, 4 Mar 88
304A	Murchison Hwy, nr Rosebery	<i>Acacia melanoxylon</i>	29 Nov 86
304B	Murchison Hwy, nr Rosebery	<i>Nothofagus cunninghamii</i>	29 Nov 86
305	Rosebery	Exotic pine trees	29 Nov 86
306	Murchison Hwy	<i>Nothofagus cunninghamii</i>	29 Nov 86
307	Murchison Hwy, Scenic Drive	<i>Nothofagus cunninghamii</i>	29 Nov 86
308	Murchison Hwy	Wet scrub	28 Mar 87 (x)
309	Zeehan - Strahan Rd	Wet scrub	28 Mar 87 (x)
310	Zeehan - Strahan Rd	Heath	28 Apr 87
311	Zeehan - Strahan Rd	Heath	29 Nov 86 (x)
312	Strahan	<i>Melaleuca ericifolia</i>	5 Mar 88
313	Strahan, Hogarth Falls	Rainforest	30 Nov 86
314A	Wellington Head	<i>Acacia melanoxylon</i> (wet/dry forest mosaic)	5 Mar 88
314B	Wellington Head	<i>Monotoca glauca</i>	5 Mar 88

Site	Locality	Vegetation	Date
314C	Wellington Head	<i>Banksia marginata</i>	5 Mar 88
314D	Wellington Head	<i>Monotoca eliptica</i>	5 Mar 88
314E	Wellington Head	Heath (mainly <i>Leptospermum</i> and <i>Melaleuca</i>)	5 Mar 88
315	Lyell Hwy	Wet scrub (mainly <i>Phebalium</i>)	1 July 86
316	Crotty Rd	<i>Nothofagus cunninghamii</i>	30 Nov 86
317	Crotty Rd	<i>Acacia melanoxylon</i>	2 July 87, 30 Nov 86
318	Crotty Rd	Wet scrub (<i>Acacia mucronata</i> and <i>Leptospermum</i>)	2 July 87 (x)
319	Crotty Rd	<i>Acacia melanoxylon</i>	2 July 87
320A	Crotty Rd	<i>Acacia mucronata</i>	2 July 87
320B	Crotty Rd	Wet scrub (<i>Acacia</i> and <i>Leptospermum</i>)	2 July 87
320C	Crotty Rd	<i>Acacia melanoxylon</i>	2 July 87
320D	Crotty Rd	<i>Nothofagus cunninghamii</i>	30 Nov 86

Site	Locality	Vegetation	Date
321A	Mt Field NP, Entrance	Exotic deciduous trees	14 July 87
321B	Mt Field NP, Entrance	<i>Acacia melanoxylon</i> (planted)	14 July 87
322A	Mt Field NP, Russell Falls Tk	dead foliage (wet forest)	3 Apr 87, 14 July 87
322B	Mt Field NP, Russell Falls Tk	dead rainforest foliage	3 Apr 87
323A	Mt Field NP, Lyrebird Nature Tk	<i>Nothofagus cunninghamii</i>	3 Apr 87, 14 July 87 (x)
323B	Mt Field NP, Lyrebird Nature Tk	<i>Acacia melanoxylon</i>	3 Apr 87
323C	Mt Field NP, Lyrebird Nature Tk	<i>Phyllocladus aspleniifolius</i>	14 July 87
324	Mt Field NP, Lake Dobson Rd	Rainforest	4 Nov 86
325A	Mt Field NP, Lake Dobson	<i>Leptospermum lanigerum</i>	14 July 87
325B	Mt Field NP, Lake Dobson	<i>Athrotaxis cupressoides</i>	14 July 87 (x)
326	Fitzgerald	Heath (mainly <i>Leptospermum</i>)	6 Apr 87, 14 July 87
327	Gordon River Road	<i>Acacia melanoxylon</i> (wet forest)	11 Apr 87
328	Maynes Rd	dead foliage (mixed forest)	12 Apr 87
329	Meullers Rd	dead foliage (mixed forest)	12 Apr 87
330	Timms Tk	Heath (<i>Leptospermum</i> and <i>Melaleuca</i>)	11 Apr 87
331A	Timms Tk	Mixed forest	11 Apr 87
331B	Timms Tk	Mixed forest	11 Apr 87
332	Needles Picnic Area	Wet forest (mainly <i>Acacia mucronata</i>)	11 Apr 87
333	Gordon River Rd	Heath (<i>Leptospermum</i> and <i>Melaleuca</i>)	11 Apr 87
334	Strathgordon, Jacks Tk	dead foliage (mixed forest)	10 Apr 87
335	Strathgordon	Wet forest (heath understorey)	10 Apr 87 (x)
336A	Scotts Peak Rd, Sandfly Creek	Heath (mainly <i>Leptospermum</i>)	11 Feb 88
336B	Scotts Peak Rd, Sandfly Creek	Wet scrub (<i>Melaleuca</i>)	11 Feb 88
337A	Scotts Peak Rd, Condominium Creek	Heath (mainly <i>Leptospermum</i>)	10 Apr 87
337B	Scotts Peak Rd, Condominium Creek	<i>Nothofagus cunninghamii</i> (dead foliage)	10 Apr 87
338	Scotts Peak Rd	<i>Acacia melanoxylon</i>	10 Apr 87 (x)
339A	Scotts Peak Rd, Lake Judd Tk Camp	<i>Acacia verticillata</i>	10 Apr 87
339B	Scotts Peak Rd, Lake Judd Tk Camp	Rainforest	10 Apr 87
340	Scotts Peak Camping Area	Heath (mainly	10 Apr 87

Site	Locality	Vegetation	Date
		<i>Leptospermum</i>)	
341	Scotts Peak Rd	Heath (mainly <i>Leptospermum</i>)	10 Apr 87
342	South West NP, Huon River Campground	<i>Nothofagus cunninghamii</i> (mixed forest)	9 Apr 87
343A	South West NP, Port Davey Tk, Crossing River	<i>Banksia</i> scrub	10 Feb 88
343B	South West NP, Port Davey Tk, Crossing River	Heath/wet scrub mosaic (<i>Leptospermum</i> and <i>Melaleuca</i>)	10 Feb 88
344	South West NP, Crossing River	Heath/wet scrub mosaic	10 Feb 88 (x)
345	South West NP, Arthur Range, Promontory Lake	Alpine vegetation	10 Feb 88 (x)
346A	South West NP, McKays Tk, Wullyacca Creek	Wet scrub	10 Feb 88
346B	South West NP, McKays Tk, Wullyacca Creek	Wet scrub	10 Feb 88
347	South West NP, Luckmans Lead, Luckmans Creek	Wet scrub/heath mosaic	11 Feb 88
348	South West NP, Thwaites Plateau	Alpine vegetation	11 Feb 88 (x)
349	South West NP, Spain Bay	Coastal vegetation	22 Mar 88
350	South West NP, Stephens Bay	Coastal vegetation	22 Mar 88
351A	South West NP, Loyhener Beach	Coastal vegetation	22 Mar 88
351B	South West NP, Loyhener Beach	<i>Myoporum insulare</i>	22 Mar 88
352	South West NP, Window Pane Bay	Tall <i>Leptospermum</i> scrub	21 Mar 88
353	South West NP, Window Pane Bay	Coastal vegetation	21 Mar 88
354	South West NP, Wilson Bight	Coastal vegetation	19 Mar 88
355	South West NP, Ketchem Bay	Coastal vegetation	19 Mar 88
356	South West NP, New Harbour Beach	Wet forest	18 Mar 88
357	South West NP, New Harbour Beach	Wet forest	18 Mar 88
358	South West NP, Melaleuca Lagoon	<i>Leptospermum</i> scrub	16 Mar 88
359A	South West NP, Half Woody Hill	dead foliage (wet forest)	16 Mar 88
359B	South West NP, Half Woody Hill	Rainforest	16 Mar 88
360	South West NP, Cox Bight	Coastal vegetation	24 Mar 88
361	South West NP, South Coast Tk, Louisa River	Mixed forest	25 Mar 88
362	South West NP, Little Deadmans Bay	Wet forest (mainly <i>Acacia melanoxylon</i>)	27 Mar 88
363	South West NP, Prion Beach	dead <i>Eucalyptus</i> foliage (wet forest)	27 Mar 88
364A	South West NP, New River Lagoon	Coastal scrub	15 Feb 88

Site	Locality	Vegetation	Date
364B	South West NP, New River Lagoon	Coastal scrub	15 Feb 88
364C	South West NP, New River Lagoon	Coastal scrub	15 Feb 88
365A	South West NP, New River Lagoon	Coastal scrub	15 Feb 88
365B	South West NP, New River Lagoon	Coastal scrub	15 Feb 88
365C	South West NP, New River Lagoon	Coastal scrub	16 Feb 88
366A	South West NP, New River Lagoon	Wet forest	16 Feb 88
366B	South West NP, New River Lagoon	Wet forest	16 Feb 88
366C	South West NP, New River Lagoon	<i>Acacia melanoxylon</i>	16 Feb 88
366D	South West NP, New River Lagoon	<i>Nothofagus cunninghamii</i>	16 Feb 88
366E	South West NP, New River Lagoon	dead <i>Eucalyptus</i> foliage (wet forest)	16 Feb 88
366F	South West NP, New River Lagoon	dead <i>Eucalyptus</i> foliage (wet forest)	16 Feb 88
366G	South West NP, New River Lagoon	dead rainforest foliage	16 Feb 88
366H	South West NP, New River Lagoon	dead rainforest foliage	16 Feb 88
367	South West NP, Prion Beach	<i>Myoporum insulare</i>	27 Mar 88 (x)
368	South West NP, Surprise Bay	Coastal vegetation	28 Mar 88

Distribution patterns and diversity of invertebrates of temperate rainforests in Tasmania with a focus on Pauropoda

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Abstract

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Pauropoda are recorded for the first time from Tasmania. Nineteen species are listed from a large collection of specimens made during an intensive survey of temperate rainforest in Tasmania. A key is provided for the identification of Tasmanian species which are recorded by voucher number and the biogeographical affinities of the fauna are discussed. Taxic richness of Pauropoda in Tasmanian rainforests is compared with that of several other groups of litter and bark invertebrates from the same collections. All groups show similar patterns of high taxic richness in the northwest and southeast regions with lower richness at higher altitudes. The implications for the conservation of Tasmania's highly endemic invertebrate fauna is discussed.

Keywords

Acarina, Amphipoda, Diplopoda, Isopoda, Opiliones, Symphyla, regional diversity, conservation priorities.

Introduction

The Pauropoda is a Class of minute Arthropoda belonging to the Subphylum, Myriapoda. It comprises around 700 hundred species worldwide that are grouped into five families. The total world fauna is likely to be in the region of 5000 species as many regions and ecosystems are under-collected (Scheller, 1990). Adults have eight to eleven pairs of legs, lack eyes and are either white or lightly sclerotised with a maximum length of about 1.5 mm (Scheller, 1990). Pauropoda tend to be soil-living but are also found in rotting logs, under bark and in moss and leaf litter. They are generally most abundant in moist soils that have high levels of organic matter. Their feeding habits vary; some groups feed on fungi and decaying organic matter while others may consume more solid food (Scheller, 1990).

Although Pauropoda have been found in humid soils under native vegetation as well as on agricultural land throughout the Australian continent, very little is known of the composition of the fauna. They are particularly species-rich and abundant in forest soils but a soil sample from under any native vegetation is likely to contain some specimens. Such data as exist indicate that there is a very high level of species endemism of probably over 90%. Moreover, there are likely to be 20 to 30 species belonging to five or so genera within a single vegetation type (Postle et al., 1991). This is the same order of magnitude as

found in the central Amazon forest where over 50 species were recorded from a single vegetation type (Scheller, 1994, 1997). The Australian fauna is estimated to comprise at least 1000 species of which only 18 species (2%) have been recorded so far. Previous records are from Queensland (Remy, 1959), New South Wales (Harrison, 1914), Victoria (Tiegs, 1943, 1947; Remy, 1949), Northern Territory (Greenslade and Mott, 1979) and Western Australia (Remy, 1957; Postle et al., 1991). A checklist for Australia is available (ABRS, ABIF, 2002). No species of pauropod have been recorded previously for Tasmania.

Although pauropods occur under both native vegetation and crops, densities are variable. In studies overseas, densities of pauropods of up to several thousand have been found in soils (Adis et al., 1999; Hågvar and Scheller, 1998; Lagerlöf and Scheller, 1989) and, on a site in Denmark, they were more abundant than Psocoptera, Coleoptera and Symphyla, and a quarter as abundant as Acarina (Hågvar and Scheller, 1998). Similar densities have been found at some sites in Australia, indicating that they comprise a significant part (5% of individuals) of the arthropod fauna (Greenslade and Mott, 1979). Abundances are reduced by fire (Broza and Izhaki, 1997).

The invertebrate biodiversity of cool temperate rainforest was sampled intensively and extensively in Tasmania as part of the National Rainforest Conservation Program (NRCP) (Coy et

al., 1993). This forest type occupies just under 600,000 hectares in Tasmania and represents 10% of the state. It is most prominent in northwestern Tasmania, with other less extensive areas in the northeast and on the east coast and occasional patches in the southwest. The survey sampled 19 localities covering all the nature conservation regions of the state accepted at the time (1990) and major rainforest types with the aim of documenting the invertebrate fauna comprehensively, identifying areas of greatest species richness and phyletic diversity and assessing impacts on the fauna (Coy et al., 1993). It was the first documentation of the invertebrate fauna within a major vegetation type in Tasmania and the first to assess the conservation status of this highly endemic and species-rich fauna. The data also provided a basis for comparison with other forest faunas within and outside Tasmania for groups that were targeted.

Listed are the Pauropoda species collected during the survey. An estimated 142,000 specimens of invertebrates were collected, among them 1087 (0.8%) Pauropoda. No earlier publications record specimens from Australian *Nothofagus* forests. Nineteen species were found in the survey, of which 17 are new. Keys to families, genera, subgenera and species are presented. Pauropod biodiversity at each locality is compared with that of other invertebrate groups from the same survey and the data used to make inferences regarding the conservation value of each region of Tasmania.

Materials and Methods.

Twelve sites covering each of the conservation regions accepted at that time (1990) in which rainforest occurred, and representing the four main rainforest communities: Callidendrous, Thamnic, Implicate and Open Montane forest, were selected for intensive sampling. The sampling was stratified so that there were two replicates in each region and two to three replicates of each of the four rainforest types. The sites are listed below (*Locs 1–12*). Besides the 12 major sites, some collecting was carried out in supplementary sites (*Locs 13–19*). On each of the 12 main sites the same sampling methods were used; Tullgren funnel extraction of soil, moss and leaf litter, pitfall trapping, yellow pan trapping, sweeping, hand collections and pyrethrin knockdown of tree trunks (PKD) (Coy et al., 1993). Only Tullgren funnel extraction of leaf litter and humus was done on the supplementary sites. Pauropods were found most abundantly in funnel extractions of soil cores, moss and litter, although a few specimens were collected by other methods. Sampling was carried out in a single season – autumn for the most part. All specimens were preserved in ethanol. Detailed descriptions of the localities are given in the NRCP report (Coy et al., 1993).

Holotypes of the species to be described in a later publication (Scheller, in prep), will be lodged in the Australian National Insect Collection and paratypes and other material in the Queen Victoria Museum.

Abbreviations

Collectors: ATW, A. Trumbull-Ward; DR, D. Rounsevell; HM, H. Mitchell; JD, J. Diggle; MN, M. Neyland; PG, P. Greenslade; RC, R. Coy; SS, S. Smith.

Collecting sites as given in Coy et al. (1993).

Loc. 1 = NRCP 1 NW Tasmania, Savage River (41°19.1'S, 145°16.2'E and 41°18.5'S, 145°16.3'E), callidendrous *Nothofagus cunninghamii* rainforest, alt. 500 m (Grid Reference CQ558,247 and CQ560,255). Conservation status: Forest Reserve, part of the "Savage River Pipeline Corridor".

Loc. 2 = NRCP 2, NW Tasmania, Bradshaws Road (41°49.9'S, 145°37.0'E), callidendrous and thamnic *Nothofagus cunninghamii* rainforest, alt. 840 m (Grid Reference CP854,680). Conservation status: Mt Murchison River Reserve.

Loc. 3 = NRCP 3, central Tasmania, Projection Bluff (41°43.1'S, 146°43.5'E), high altitude callidendrous rainforest dominated by *Nothofagus cunninghamii*, alt. 1100 m (Grid Reference DP770,812). Conservation status: World Heritage Area.

Loc. 4 = NRCP 4, NW Tasmania, Cradle Mountain campground (41°35.4'S, 145°55.9'E), high altitude callidendrous rainforest dominated by *Nothofagus cunninghamii*, alt. 880 m (Grid Reference DP109,955). Conservation status: part conservation area.

Loc. 5 = NRCP 5, NE Tasmania, Mt Victoria (41°20.4'S, 147°49.9'E), callidendrous *Nothofagus cunninghamii* forest, alt. 900 m (Grid Reference EQ693,233). Conservation status: forest reserve.

Loc. 6 = NRCP 6, NE Tasmania, Mt Michael (41°10.9'S, 148°00.4'S), heavily logged callidendrous *Nothofagus cunninghamii* rainforest, alt. 740 m (Grid Reference EQ845,406). Conservation status: blue tier forest reserve.

Loc. 7 = NRCP 7, SE Tasmania, Big Sassy Creek, (42°08.5'S, 147°54.3'E), small strip of *Atherosperma moschatum* dominated callidendrous rainforest along the creek, alt. 400 m (Grid Reference EP749,332). Conservation status: forest reserve.

Loc. 8 = NRCP 8, SE Tasmania, Sandspit River (42°42.1'S, 147°51.5'E), mixed *Eucalyptus regnans* and *Atherosperma moschatum* callidendrous forest, alt. 180 m (Grid Reference EN703,713). Conservation status: forest reserve.

Loc. 9 = NRCP 9, SW Tasmania, Frodshams Pass (42°49.7'S, 146°22.9'E), callidendrous/thamnic and implicate rainforest dominated by *Nothofagus cunninghamii*, alt. 620 m (Grid Reference DN497,580). Conservation status: World Heritage Area.

Loc. 10 = NRCP 10, SW Tasmania, Mt Field, below Lake Fenton (42°40.9'S, 146°37.5'E), open montane low canopy *Nothofagus gunnii* forest, alt. 980 m (Grid Reference DN695,746). Conservation status: national park.

Loc. 11 = NRCP 11, SE Tasmania, Tasman Peninsula (43°08.2'S, 147°54.5'E), small remnant of callidendrous-thamnic intermediate cloud forest dominated by *Nothofagus cunninghamii* remains within an eucalypt dominated forest, mixed forest, alt. 400 m (Grid Reference EN742, 346). Conservation status: not reserved.

Loc. 12 = NRCP 12, SE Tasmania, Mt Mangana, Bruny I (43°22.1'S, 147°17.0'E), low-canopy callidendrous-thamnic intermediate rainforest dominated by *Nothofagus cunninghamii* on Mt Mangana, alt. 540 m (Grid Reference EM229, 980). Conservation status: forest reserve.

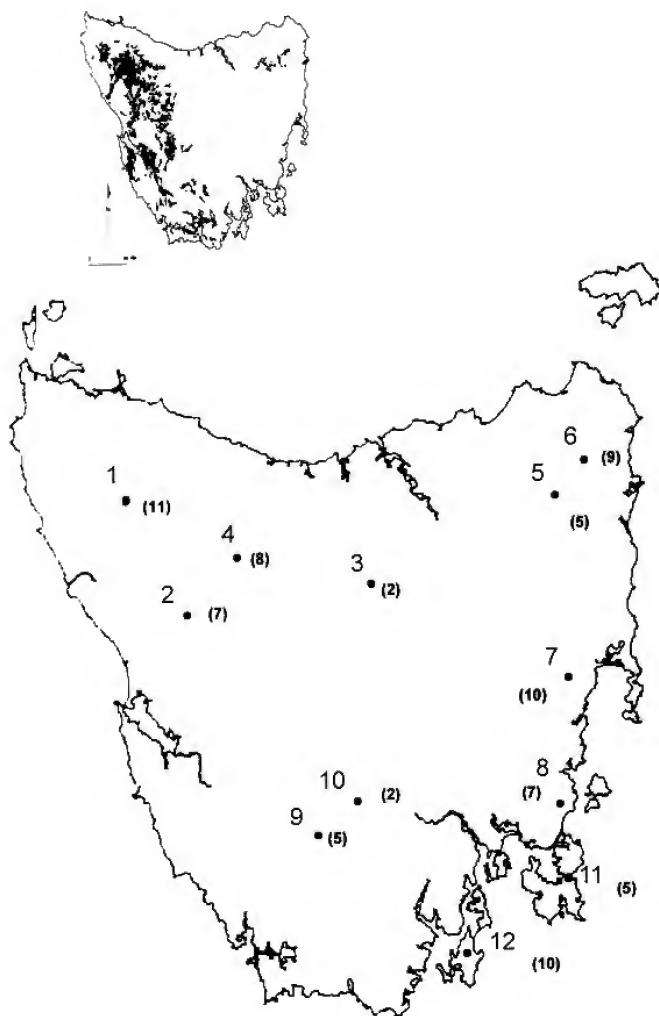


Figure 1. Location of collecting sites, numbered from 1 to 12 as in the text. Numbers in brackets indicate total number of pauropod species found on each site. Insert shows distribution of rainforest in Tasmania taken from Coy et al. (1991).

Loc. 13 = NW Tasmania, Hibbs Lagoon ($42^{\circ}34'S$, $145^{\circ}19.5'E$), rainforest (Grid Reference CN623, 853). Conservation status: South West Conservation Area.

Loc. 14 = N Tasmania, Mt Stronach ($41^{\circ}10'S$, $147^{\circ}34'E$), rainforest (Grid Reference EQ476, 422). Conservation status: forest reserve.

Loc. 15 = N Tasmania, Asbestos Ranges ($41^{\circ}09'S$, $146^{\circ}40'E$), North Leg, rainforest (Grid Reference DQ727, 444). Conservation status: national park.

Loc. 16 = SW Tasmania, Riveaux Creek ($43^{\circ}10'S$, $146^{\circ}38.6'E$), Huon pine rainforest (Grid Reference DN704,

205). Conservation status: World Heritage Area.

Loc. 17 = NE Tasmania, Simons Road ($41^{\circ}21.5'S$, $147^{\circ}31.3'E$), (Grid Reference EQ435, 212). Conservation status: special forestry management zone for springtails.

Loc. 18 = N Tasmania, Saxons Creek ($41^{\circ}15'S$, $146^{\circ}40'E$), rainforest (Grid Reference DQ751, 316). Conservation status: not reserved.

Loc. 19 = SW Tasmania, Old Farm Road, Mt Wellington, ($42^{\circ}54'S$, $147^{\circ}16'E$), *Eucalyptus* forest. Conservation status: national park.

Checklist and distributions of Tasmanian Pauropoda

Regions: NW – northwest, NE – northeast, N – north, C – central, SE – southeast, SW – southwest

Family Pauropodidae**Genus *Allopaupopus* s.str.**

Subgenus *Allopaupopus* Silvestri, 1902

Type species: *Allopaupopus brevisetus* Silvestri, 1902

Allopaupopus (*Allopaupopus*) sp. nov. 1 NW, NE, SE, SW

Allopaupopus (*Allopaupopus*) sp. nov. 2 SE

Subgenus *Decapaupopus* Remy, 1931

Type species: *Allopaupopus* (D.) *cuenoti* (Remy)

Decapaupopus cuenoti Remy, 1931

Allopaupopus (*Decapaupopus*) sp. nov. 3 SE, NW, SW, N

Allopaupopus (*Decapaupopus*) sp. nov. 4 NW, SE

Allopaupopus (*Decapaupopus*) sp. nov. 5 SW

Allopaupopus (*Decapaupopus*) sp. nov. 6 NW

Allopaupopus (*Decapaupopus*) sp. nov. 7 NW, SE

Allopaupopus (*Decapaupopus*) sp. nov. 8 NW, NE, SW

Genus *Cauvetaupopus* Remy, 1952

Type species: *Cauvetaupopus microchaetus* (Remy, 1952)

Allopaupopus microchaetus Remy, 1948

Subgenus *Nesopaupopus* Scheller, 1997

Type species: *Cauvetaupopus* (*Nesopaupopus*) *biglobulosus* Scheller, 1997

Cauvetaupopus (*Nesopaupopus*) sp. nov. 9 NE

Genus *Stylopaupopoides* Remy, 1956

Type species: *Stylopaupopoides tiegsi* (Remy, 1949)

Stylopaupopoides ringueleti Remy, 1962 NW, N, SW

Stylopaupopoides sp. nov. 11 NW, NE, SE, N

Stylopaupopoides sp. nov. 12 NW, NE, SE, SW

Stylopaupopoides sp. nov. 13 NW, SE, C, NE, SW

Stylopaupopoides sp. nov. 14 NW, C, NE, SE, SW

Stylopaupopoides sp. nov. 15 NW, NE, SE

Stylopaupopoides sp. nov. 16 NW

Genus *Pauropus* Lubbock, 1867

Type species: *Pauropus huxleyi* Lubbock, 1867

Pauropus dolosus Remy, 1956 SE

Pauropus sp. nov. 18 NW, NE, SE, SW

Brachypauropodidae**Genus *Brachypauropoides* Remy, 1952**

Type species: *Brachypauropoides pistillifer* Remy 1952

Brachypauropoides sp. nov. 19 NW, NE, SE

Key to Tasmanian Pauropoda

1. Body fusiform; tergites entire, generally not distinctly ; legs longer than length of segment Pauropodidae 2
Body oval, somewhat flattened; tergites most often divided, generally distinctly sclerotized; legs equal to or shorter than length of segment Brachypauropodidae
2. All legs 5-segmented *Cauvetaupopus*
First and last pair of legs 5-segmented, all other legs 6-segmented 3
3. Anterior margin of sternal antennal branch nearly always distinctly shorter than posterior margin ... *Allopaupopus* 5
Anterior and posterior margins of sternal antennal branch nearly always of subequal length 4
4. Pygidial sternum with setae b1 + b2 *Pauropus* 19
Pygidial sternum with setae b1 only *Stylopaupopoides* 13
5. Pygidial sternum with setae b1 and b2 only *A. (Decapaupopus)* 8
Pygidial sternum with setae b1 and b2 and b3 *A. (Allopaupopus)* s. str 6
6. Temporal organs without anterior appendage; distal part of T3 cylindrical; anal plate with straight posterior margin *A. (A.)* sp. 1
Temporal organs with distinct anterior appendage; T3 with ovoid distal swelling; anal plate with long posteromedian process *A. (A.)* sp. 2
8. Antennal globulus g not as wide as maximum diameter of tergal branch t 9
Antennal globulus g wider than maximum diameter of tergal branch t *A. (D.)* sp. 8
9. Distal swelling on T3 absent 10
Distal swelling on T3 present *A. (D.)* sp. 6
10. Posterior margin of anal plate incised 11
Posterior margin of anal plate rounded *A. (D.)* sp. 3
11. Seta on coxa of last pair of legs furcate; T3 with simple pubescent hairs 12
Seta on coxa of last pair of legs simple; T3 with branched pubescent hairs *A. (D.)* sp. 5
12. Appendage of collum segment incised anteriorly; proximal 2/3 of T3 thickened *A. (D.)* sp. 4

- Appendage of collum segment pointed anteriorly; T3 with thin axes *A. (D.)* sp. 7
13. Branches of anal plate separated by V-shaped incision 14
 Branches of anal plate separated by U-shaped incision *S.* sp. 16.
14. Lateral appendages on anal plate absent 15
 Lateral triangular appendages on anal plate distinct *S.* 13
15. Distal appendages of anal plate with flat posterior surface 16
 Distal appendages of anal plate with convex posterior surface *S.* sp. 14
16. Anteriodistal and posteriodistal corners of sternal antennal branch equally truncate; pygidial b1 evenly curved 17
 Posteriodistal corner of sternal antennal branch distinctly more truncate than anteriodistal one, pygidial b1 undulate *S.* sp. 11
17. T3 with long simple branches or with branched pubescence; setae on tergites fine 18
 T3 with very simple pubescence hairs; setae on tergites and head clavate *S.* sp. 15
18. Distal part of all trichobothria except for T5 with simple curved pubescent branches; st cylindrical blunt *S.* sp. 10
 Distal part of all trichobothria without branches except T5 but with branched pubescent hairs; st thin, tapering, pointed *S.* sp. 12
19. Pygidial st subcylindrical tapering; posterior appendages of anal plate short and blunt *P. dolosus*
 Pygidial st similar to a knife blade; posterior appendages of anal plate long, thin and pointed *P.* sp. 18

Discussion

Composition and affinities. In Tasmania, as elsewhere, the Pauropodidae is the most diverse family as all but one of 19 species belong to it. Of its five subfamilies, only the Pauropodinae is present, already known to be the most widespread and most species rich subfamily worldwide. The Tasmanian rainforest fauna is relatively rich in species, but unexpectedly no species in the family Eurypauropodidae was collected. This is a widely distributed family with representatives in Borneo, New Guinea and New Caledonia and on mainland Australia (New South Wales). The family is also found in cooler localities in Great Britain and Central Europe, northern USA and at over 2000 m in the Himalayas (Scheller, 1990 and included references).

The majority of the NRCP specimens belong to two genera, *Allopaupopus* with eight species and *Stylopaupopoides* with seven species, together comprising 80% of the species. Postle et al. (1991) found 39 species in forests in south Western

Australia but over a longer period. Of these 31 (80%) belonged to either *Stylopaupopoides* or *Allopaupopus*. As here, a large proportion of the fauna was undescribed as only two species were already named. *Allopaupopus* is near cosmopolitan and the most widespread and most diverse genus of pauropods with nearly 200 species known worldwide, so the high number of *Allopaupopus* species in Australia is not surprising.

The genus *Stylopaupopoides* has its main distribution in the southern hemisphere and is not often encountered in the north. Its southerly range indicates a Gondwanan origin and its absence from the southern part of Africa may be a result of lack of collecting. Thirteen species have been described but only one from north of the equator (Ivory Coast and Guinea). A list of species in the genus with their distributions is given in Table 1. The six new species from Tasmania suggests a high concentration of species in this genus in Tasmanian rainforests.

Pauropus also occurs worldwide hence is considered near cosmopolitan as well. The other genera, *Cauvetaupopus* and *Brachypauropoides*, have wide but more southerly distributions. Only ten species have been described in *Cauvetaupopus*, but they are distributed over a very large area from Brazil, France, north and tropical Africa, the Seychelles and Sri Lanka. The same is true of *Brachypauropoides*, now known from Madagascar, Borneo and New Zealand.

Affinities are strong between Tasmania and New Zealand. As noted above for Tasmanian rainforest, the genus *Stylopaupopoides* – with nearly 40% of total species and 57% of total specimens collected – is well represented. The genus is also diverse and abundant in New Zealand where six species have been described (Remy, 1952, 1956a, 1956b), one of which is also known from mainland Australia (Remy, 1949). In another New Zealand collection, 106 pauropods were studied in which *Stylopaupopoides* represented 35% of the species and 74% of the specimens (Remy, 1952, 1956a, 1956b). Although collecting methods and vegetation in the two surveys differed, the results indicate that the genus is particularly diverse in these two regions. Other similarities with New Zealand are in the genera *Brachypauropoides* and *Pauropus*. The former was known previously from Madagascar, Borneo and New Zealand, and the Tasmanian species is close to one of the two New Zealand species, *B. pistillifer* Remy. *Pauropus dolosus* is common to New Zealand and Tasmania and *A. sp. 1* is close to *A. maoriorum* Remy from New Zealand.

In conclusion the Tasmanian rainforest fauna is rich in species but of low generic diversity, and affinities are strongest at the species and generic level with New Zealand as might be expected (Kantvilas et al., 1985).

Habitats. The Tasmanian collections recorded pauropods from tree trunks (5 species) and tree ferns (1 species) for the first time. Both habitats were sampled by pyrethrin knock-down. Numerous specimens of several species (15 species, 71 records) were collected from moss on sites where they were not common in other habitats. In rainforest, moss commonly has a higher moisture content which may account for higher species richness here.

Abundance. Species varied in numbers of specimens caught from one individual to over 200. Seven species were represented

Table 1. List of known species in the genus *Stylopauropoides* with their distributions. In addition six new species from Tasmania are recorded in this paper.

Species	Localities	References
1. <i>S. tiegsi</i> (Remy)	Australia (eastern) New Zealand	Remy 1949 Remy 1952c, 1956a, 1956b
2. <i>S. bornemisszai</i> Remy	Australia (western)	Remy 1957, Postle <i>et al.</i> 1991
3. <i>S. ringueleti</i> Remy	Argentina Chile Tasmania	Remy 1962 Scheller 1968 New record
4. <i>S. lambda</i> Remy	New Zealand	Remy 1956b
5. <i>S. subantarcticus</i> Scheller	Crozet Islands	Scheller 1974
6. <i>S. infidus</i> (Remy)	New Zealand	Remy 1956a
7. <i>S. duplex</i> (Remy)	New Zealand	Remy 1956a
8. <i>S. bilobatus</i> Scheller	New Caledonia	Scheller 1993
9. <i>S. hirtus</i> (Remy)	New Zealand	Remy 1952c, 1956a
10. <i>S. delamarei</i> (Remy)	Ivory Coast Guinea	Remy 1948 Remy 1959a
11. <i>S. vadoni</i> (Remy)	Madagascar	Remy 1956c, Remy & Bello 1960
12. <i>S. incisus</i> Remy & Bello	Madagascar	Remy & Bello 1960
13. <i>S. furcillatus</i> (Remy)	New Zealand New Caledonia	Remy 1952c Scheller 1993

by fewer than 20 individuals (37%), eight species represented by between 21 and 99 individuals (42%) and four species (21%) represented by over 100 individuals. There was a distinct trend for the most numerous species to be the most widespread, as expected.

Regional distribution. Because the NRCP material comes almost exclusively from rainforests (fig. 1), species occurrence in other vegetation types is not known. Within rainforests, most species were found to be distributed widely in the state being recorded from all major regions (table. 2). Seven species were widely distributed: *A. sp.1*, *A. sp. 3*, *S. sp. 11*, *S. sp. 12*, and *P. sp. 18*, were found in four regions and *S. sp. 13* and *S. sp. 14* in five regions. Two other species, *S. sp. 15* and *S. sp. 19* seem to have more northerly and easterly distributions; two, *A. sp. 8* and *S. ringueleti*, were most commonly found in the northern and southwest regions, and two species recorded from both northwest and southeast regions, *A. sp. 4* and *A. sp. 7*. Six species, *A. sp. 2*, *A. sp. 5*, *A. sp. 6*, *C. sp.9*, *S. sp. 16* and *P. dolosus* were only found at a single site and may be short range endemics. This is a high proportion (30%) of rare species

although it is also possible that some of these species at least are have a preference for other vegetation types such as eucalypt forest.

Regional diversity. Faith (1992) described a method of ranking sites based on phyletic diversity in which branch lengths on a phylogenetically derived tree of relationships were used as a measure of divergence and hence conservation uniqueness. Faith and Greenslade (1994) provided a preliminary analysis of three groups of invertebrates from the NRCP sites which indicated that the northwestern sites (*Locs 1, 2 and 4*) were major contributors to phyletic diversity. Although phylogenetic trees are not available for any of the groups (except for Triaenonychidae Opiliones (Hunt, 1996), new taxonomic information is available for three more groups. In the absence of relationship trees, the data are used to calculate the simple measure of "taxic" diversity for six groups; Diplopoda (R. Mesibov, unpublished data), Opiliones (G. Hunt, unpublished data), euryctymite oribatid mites (Niebala and Colloff, 1997), Amphipoda (A. Friend, unpublished data) and Isopoda (A. Green, unpublished data) in addition to the Pauropoda (tables 1

Table 2. Records of Pauropoda species from NRCP sites with total species, subgenera, genera, families and taxic score for each site

Species	Sites														Number of records	
	1	2	3	4	5	6	7	8	9	10	11	12	Other sites	Main sites	Other sites	
<i>Allopauropus</i> sp. nov. 1	+	+		+		+	+					+	13,16	6	2	
<i>Allopauropus</i> sp. nov. 2							+	+				+		3	0	
<i>Allopauropus</i> sp. nov. 3		+					+	+			+	+	13,16,18,19	5	4	
<i>Allopauropus</i> sp. nov. 4				+			+				+	+		4	0	
<i>Allopauropus</i> sp. nov. 5													16	0	1	
<i>Allopauropus</i> sp. nov. 6	+													1	0	
<i>Allopauropus</i> sp. nov. 7				+								+		2	0	
<i>Allopauropus</i> sp. nov. 8	+				+				+					3	0	
<i>Cauvetauropus</i> sp. nov. 9						+								1	0	
<i>Stylopauropoides ringueleti</i> Remy, 1962		+											14,15,19	1	3	
<i>Stylopauropoides</i> sp. nov. 11	+	+		+	+	+	+				+		17, 18	7	2	
<i>Stylopauropoides</i> sp. nov. 12	+			+	+	+	+		+			+	13,16,17	7	3	
<i>Stylopauropoides</i> sp. nov. 13	+		+	+		+	+	+	+		+	+	13,17,19	9	3	
<i>Stylopauropoides</i> sp. nov. 14	+	+	+	+	+	+	+	+	+	+		+		11	0	
<i>Stylopauropoides</i> sp. nov. 15	+			+	+	+	+						17	5	1	
<i>Stylopauropoides</i> sp. nov. 16	+												13	1	1	
<i>Pauropus dolosus</i> Remy, 1956								+			+	+		3	0	
<i>Pauropus</i> sp. nov. 18	+	+				+		+	+	+		+	13,17	7	2	
<i>Brachypauropoides</i> sp. nov. 19	+	+				+	+	+					13,17	5	2	
Total species	11	7	2	8	5	9	10	7	5	2	5	10				
Total subgenera	5	5	1	3	2	5	4	5	2	2	3	4				
Total genera	4	4	1	2	2	5	3	4	3	2	3	3				
Total families	2	2	1	1	1	2	2	2	1	1	1	1				
TAXIC SCORE	22	18	5	14	10	21	19	18	11	7	12	18				

and 2). These groups include a variety of decomposer groups and a predatory and scavenger group (Opiliones) and were selected partly on the basis that they were characteristic of rainforest faunas and also because they showed a negative response to disturbance (Coy et al., 1993; Greenslade, 1992); hence they could act as surrogates for the whole rainforest fauna. They were also the only groups for which all species identifications were available. There were some differences in the total number of species found in each higher taxon with Opiliones being the largest group with 34 species, followed by euptyctime oribatid Acarina with 31, Diplopoda with 29, Isopoda with 28, Pauropoda with 19 and Amphipoda with 17.

The appendix lists species identified from the collections. The larger numbers of euptyctime oribatid Acarina, Diplopoda and Opilione species compared with smaller detritivores such as Pauropoda, may be a characteristic of rainforest faunas.

Table 2 summarises the site record data for all 19 species of pauropod. The number of species, subgenera, genera and families at each of the main twelve localities is given and these figures summed, without weighting, to give an simple overall "taxic" richness". This method gives more weight to the phylogenetic diversity found on each site than does a simple species richness count and is used here because of the absence of any formal phylogenetic analysis. The collecting intensity

Table 3. Numbers of species, genera, families and total taxic score of Pauropoda, euryctym oribatid mites (Niebala and Colloff, 1997), Opiliones (G. Hunt, pers. comm.), Diplopoda (R. Mesibov, pers. comm.), Amphipoda (A. Friend, pers. comm.) and Isopoda (A. Green, pers. comm.) recorded on each of the twelve main NRCP sites during the survey.

Taxa		Sites											
		1	2	3	4	5	6	7	8	9	10	11	12
Pauropoda	species	11	7	2	8	5	9	10	7	5	2	5	10
	genera	4	4	1	2	2	5	3	4	3	2	3	3
	families	2	2	1	1	1	2	2	2	1	1	1	1
	Taxic diversity	17	13	4	11	8	16	15	13	9	5	9	14
Oribatid mites	species	17	12	4	0	6	3	8	6	6	4	10	15
	genera	3	5	3	0	3	2	3	3	2	2	3	4
	families	2	3	2	0	1	1	2	2	1	1	2	2
	Taxic diversity	22	20	9	0	10	6	13	11	9	7	15	21
Opiliones	species	11	12	1	1	12	10	7	10	4	1	3	8
	genera	6	9	1	1	10	7	6	9	2	1	2	6
	families	3	3	1	1	3	3	2	2	2	1	1	3
	Taxic diversity	20	24	3	3	25	20	15	21	8	3	6	17
Diplopoda	species	9	6	0	2	6	2	6	4	2	2	3	5
	genera	6	5	0	2	5	2	5	4	1	1	3	4
	families	3	2	0	2	1	2	4	4	1	1	2	3
	Taxic diversity	18	13	0	6	12	6	15	12	4	4	8	12
Amphipoda	species	5	4	0	0	0	0	0	1	2	0	2	6
	genera	4	4	0	0	0	0	0	1	2	0	2	5
	families	1	1	0	0	0	0	0	1	1	0	1	1
	Taxic diversity	10	9	0	0	0	0	0	3	5	0	5	12
Isopoda	species	12	9	1	7	6	4	5	7	5	3	6	7
	genera	5	5	1	3	3	2	4	4	2	1	3	3
	families	4	4	1	2	2	2	3	3	2	1	3	3
	Taxic diversity	21	18	3	12	11	8	12	14	9	5	12	13
Total taxic diversity		108	97	19	32	66	56	70	74	44	24	55	89
Site ranking		1	2	12	10	6	7	5	4	9	11	8	3

was identical at all the 12 main sites so providing a solid basis for comparison. The data indicates that the Savage River site (NW *Loc. 1*) is the most taxic rich site followed by Mt Michael (NE, *Loc. 6*) and Big Sassy Creek (SE, *Loc. 7*). Three other sites (NW *Loc. 2*, SE *Loc. 8* and SE *Loc. 12*) all have an equal score so high taxic richness appears to be spread over all regions except for the southwest and central north.

Total taxic richness for the five other groups and a mean ranking for all sites is shown together with the pauropod data in tables 3 and 4. There is a tendency for all the groups to show similar patterns of species richness between localities as that shown by the pauropods. Localities from the northwest and southeast (1, 2, 6, 7 and 12) have consistently high rankings for all six invertebrate groups while localities 3, 4, 9 and 10 are consistently low. The same pattern was found when the taxic diversity was calculated using a weighting system (not shown). Apart from Frodshams Pass (9), the other three sites with low

scores are all high altitude rainforest (over 880m). Overall there is a trend of decreasing taxic diversity with altitude for all sites with a significant negative correlation of taxic diversity with altitude of $r = -.61$, $p < 0.05$. This finding is not surprising given the sparser tree cover resulting in more open vegetation and, presumably, higher dessication rates at the higher altitudes. Although montane vegetation types were not present at Frodshams Pass, it was located at a high altitude and three types of rainforest were sampled rather than only the more common Calledendrous type, which may be the reason for its low species richness.

The Symphyla which were also studied from these collections (Clarke and Greenslade, 1996) also showed a higher species richness from localities 1 and 2 in the northwest than 7 to 9 and 11 and 12. Material from sites 3 to 6 and 10 were not studied so this taxon has not been included here.

Factors affecting the taxic diversity, apart from altitude, rainforest type or region could be annual rainfall, area of

Table 4. Individual and mean rankings of taxic scores of selected invertebrates from the twelve main rainforest sites

	Pauropoda		Oribatid Acari		Opiliones		Diplopoda		Amphipoda		Isopoda				
Sites	Taxic diversity	Ranking	Taxic diversity	Ranking	Taxic diversity	Ranking	Taxic diversity	Ranking	Taxic diversity	Ranking	Taxic diversity	Ranking	Summed ranks	Mean rank	Final rank based on summed ranks
1	17	1	22	1	20	4	18	1	10	2	21	1	10	2	1
2	13	5	20	3	24	2	13	3	9	3	18	2	18	3	2
3	4	12	9	8	3	10	0	12	0	7	3	12	61	10	12
4	11	7	0	12	3	10	6	9	0	7	12	5	50	8	10
5	16	2	13	5	15	7	15	2	0	7	12	5	29	5	5
6	16	2	6	11	20	4	6	8	0	7	8	10	42	7	8
7	15	3	13	5	15	7	15	2	0	7	12	5	29	5	5
8	13	5	11	6	21	3	12	4	3	6	14	3	27	5	4
9	8	10	9	8	6	8	4	10	5	4	9	9	49	8	9
10	5	11	7	10	3	10	4	10	0	7	5	11	59	10	11
11	9	8	15	4	6	8	8	7	5	4	12	5	36	6	7
12	14	4	21	2	17	6	12	4	12	1	13	4	21	4	3

rainforest or conditions during collection. Highest rainfall is recorded from high altitude localities as well as in the extreme northwest and east, while lowest rainfall occurs in the southeast. It does not appear that average rainfall is influencing taxic richness. It should be noted, however, that rain fell heavily during sampling at *Loc. 2* and fauna was particularly active at this site during collection.

The similarity shown by the different invertebrate groups gives the taxic pattern more validity than that from a single group. Moreover, the large number of species (158), genera (67) and families (20) as well as higher groups (six) contributing to the patterns, add to its significance. These results demonstrate the value of such targeted surveys, such as this one supported by the NRCP, especially when sampling is carried out strategically.

Conservation values. Few sites, apart from those in the World Heritage Area, were formally reserved within the parks system at the time the project was carried out (1990), although several sites are now specially protected forest reserves and so are not subject to logging. *Loc. 1* was gazetted in part to protect invertebrates, although only a corridor along the Savage River pipeline has been reserved; other tracts of forest in this region remain unprotected. *Locs 1* (Savage River), *6* (Big Sassy Creek) and *16* (Riveaux Creek) are unique in that a different pauropod

species occurs on each and nowhere else. Riveaux Creek, just within the World Heritage Area, is the only site sampled with the rare rainforest tree, *Lagerstrobus franklinii* (Huon pine) and no *Nothofagus*. The reservation status of these three sites is relatively secure and not subject to logging but one important site for invertebrates, Simons Road, is subject to logging. This site should be designated as a protected forestry reserve.

Information on invertebrates from the NRCP survey has already provided the basis for special protection for several localities and all the twelve main localities, not formally protected by other legislation, were accepted for listing on the National Estate Register. With the enactment of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, however, land managers were no longer obliged to consult the register when assessing applications for developments on sites with native ecosystems. The recommendation from the NRCP 1990/1 survey was that *Locs. 1, 2, and 6*, not then protected, should be designated special reserves to provide for improved management of these sites for protection of invertebrate biodiversity. Since that time this has largely been achieved.

The conservation of Tasmanian rainforest is of high importance because it is only here that large tracts of it remain in Australia, most notably in the northwest (Anon, 2008).

Decisions on selection of reserves until recently has been largely based on vegetation and, in the RFA process, vegetational associations were given most weight (Anon, 1997). Because invertebrates integrate environmental variables at a finer scale than do plants and are more species rich, they exhibit a higher level of small scale endemism than do plants (Harvey, 2002). It has previously been noted that *Nothofagus* rainforest exhibits a higher level of generic diversity for Collembola than other vegetation types in the state (Greenslade, 1987) and the results of the NRCP survey emphasised this point. The species richness of invertebrates found in this vegetation type in Tasmania was estimated at around 750 (excluding two species rich groups, the Hymenoptera and Diptera) (Coy et al., 1993). Although only a proportion of the known fauna is reported in this paper (20%), the data illustrate their relevance to land management especially in decisions on formal reserves because invertebrates have an apparent high degree of endemism, even in a single forest type such as *Nothofagus* rainforest.

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References

- Adis, J., Scheller, U., de Moraes, J.W., and Rodrigues, J.M.G. 1999. Abundance, species composition and phenology of Pauropoda (Myriapoda) from secondary upland forest in Central Amazonia. *Revue Suisse de Zoologie* 106: 555–70.
- ABRS/AFD 2002. Checklist for Australian Pauropoda. Australian Biological Resources Study, Australian Faunal Directory. <http://www.environment.gov.au/cgi-bin/abrs/fauna/details.pl?pstrVol=P AUROPODA;pstrTaxa=1;pstrChecklistMode=2> Accessed March 2008.
- Anon. 1997. Tasmanian Regional Forest Agreement 1997. Tasmanian Department of Primary Industries and Water. <http://www.dpiw.tas.gov.au/intertext.nsf/WebPages/BHAN-54744c?open> (Accessed May 2008.)
- Anon. 2008. Rainforest in Tasmania. Tasmanian Department of Primary Industries and Water. <http://www.dpiw.tas.gov.au/intertext.nsf/WebPages/BHAN-54744c?open> (Accessed May 2008.)
- Broza, M., and Izhaki, I. 1997. The impact of intense fire on the soil Arthropod community in Mediterranean pine forest in Israel: time post-fire, seasonality and influence of tree species. *International Journal of Wildland Fire* 7: 317–25.
- Clark, S., and Greenslade, P. 1996. Review of Tasmanian *Hanseniella* Bagnall (Symphyla: Scutigerellidae). *Invertebrate Taxonomy* 10: 189–212.
- Coy, R., Greenslade, P., and Rounsevell, D. 1993. A survey of invertebrates in Tasmanian rainforest. *Tasmanian National Rainforest Conservation Programme Report* no. 9. Tasmania: Parks and Wildlife Service and Canberra: Department of Arts, Sport, the Environment and Territories. 104 pp.
- Faith, D.P. 1992. Conservation evaluation and phylogenetic diversity. *Biological Conservation* 61: 1–10.
- Faith, D.P., and Greenslade, P. 1994. Phyletic diversity and the assessment of invertebrate biodiversity of Tasmanian rainforest areas. P.90 in: *Proceedings of the International Forest Biodiversity Conference, Conserving biological diversity in temperate forest ecosystems – towards sustainable management*. Centre for Resource and Environmental Studies, Australian National University: Canberra.
- Greenslade, P. 1987. Generic biogeography of Tasmanian Collembola. Pp 653–60 in *Soil Fauna and Soil Fertility* in: Striganova, B.R. (ed.), *Proceedings of the Ninth International Colloquium on Soil Zoology* 1985. Moscow.
- Greenslade, P. 1992. Conserving Invertebrate diversity in agricultural, forestry and natural ecosystems in Australia. *Agriculture, Ecosystems and Environment* 40: 297–312.
- Greenslade, P., and Mott, J.J. 1982. Collembola and other soil and surface fauna of native and improved pastures at Katherine, Northern Territory. Pp 299–307 in: Lee, K.E. (ed.) *Proceedings of the Third Australian Conference on Grassland Invertebrate Ecology*. CSIRO: Melbourne.
- Hågvar, S., and Scheller, U. 1998. Species composition, developmental stages and abundance of Pauropoda in coniferous forest soils of southeast Norway. *Pedobiologia* 42: 278–82.
- Harrison, L. 1914. On some Pauropoda from New South Wales. *Proceedings of the Linnean Society of New South Wales* 39: 615–34.
- Harvey, M. 2002. Short-range endemism amongst the Australian fauna: some examples from non-marine environments. *Invertebrate Systematics* 16(4): 555–70.
- Hunt, G.S. 1996. A preliminary phylogenetic analysis of Australian Triaenonychidae (Arachnidae: Opiliones). *Revue Suisse de Zoologie* vol. hors série: 295–308.
- Lubbock, J. 1867. On Pauropus, a new type of centipede. *Transactions of the Linnean Society of London* 26: 181–90.
- Lagerlöf, J., and Scheller, U. 1989. Abundance and activity of Pauropoda and Symphyla (Myriapoda) in four cropping systems. *Pedobiologia* 33: 315–21.
- Kantvilas, G., James, P.W., and Jarman, S.J. 1985. Macrolichens in Tasmanian Rainforests. *Lichenologist* 17(1): 67–83.
- Niedbala, W., and Colloff, M.J. 1997. Euptyctime oribatid mites from Tasmanian rainforest (Acari: Oribatida). *Journal of Natural History* 31: 489–538.
- Postle, A.C., Majer, J.D., and Bell, D.T. 1991. A survey of selected soil and litter invertebrate species from the northern jarrah (*Eucalyptus marginata*) forest of Western Australia, with particular reference to soil-type, stratum, seasonality and the conservation of forest fauna. Pp. 193–203 in: Lunney, D. (ed.), *Conservation of Australia's Forest Fauna*. Royal Zoological Society of New South Wales.
- Remy, P.A. 1931. Un nouveau type de Pauropode: *Decapauropus cuenoti*, nov. gen., nov. sp. *Archives de Zoologie expérimentale et générale* 71: 67–83.
- Remy, P.A. 1948. Pauropodes de la Côte d'Ivoire, Afrique Occidentale Française. *Mémoires du Muséum National d'Histoire Naturelle Paris*, (n.s.) 27: 115–52.
- Remy, P.A. 1949. Sur quelques pauropodes d'Australie. *Memoirs of the National Museum, Melbourne* 16: 51–58.
- Remy, P.A. 1952. Pauropodes de Nouvelle-Zélande. *Records of the Canterbury Museum* 6: 167–79.
- Remy, P.A. 1956a. New Zealand Pauropoda in the Canterbury Museum. *Records of the Canterbury Museum* 7: 13–28.
- Remy, P.A. 1956b. Sur quelques Pauropodes de Nouvelle-Zélande. *Bulletin du Muséum National d'Histoire Naturelle Paris* (2) 28: 213–17.

- Remy, P.A. 1956c. Pauropodes de Madagascar. *Mémoires de l'Institut Scientifique Madagascar* (A) 10: 101–220.
- Remy, P.A. 1957. Pauropodes d'Australie Occidentale. *Bulletin de la Société Entomologique de France* 62: 136–44.
- Remy, P.A. 1959. Pauropodes des monts Nimba (Guinée). *Bulletin de l'Institut Française d'Afrique Noire* (A) 21: 1009–1020.
- Remy, P.A. 1962. Pauropodes Sud-Américains. *Biologie de l'Amérique Australe* 1: 49–61.
- Remy, P.A. & Bello, J. 1960. Pauropodes du massif de l'Ankaratra (Madagascar). *Mémoires de l'Institut Scientifique Madagascar* (A) 14: 71–93.
- Scheller, U. 1968. Chilean and Argentinian Pauropoda. *Biologie de l'Amérique Australe* 4: 275–306.
- Scheller, U. 1974. Two Pauropodidae species (Myriapoda, Pauropoda) from the Subantarctic Crozet Islands. *Entomologica Scandinavica* 5: 59–65.
- Scheller, U. 1990. Pauropoda. Pp. 861–890 in: Dindal, D. (ed.), *Soil Biology Guide*. John Wiley and Sons: New York.
- Scheller, U. 1993. Pauropoda (Myriapoda) from New Caledonia. In: *Zoologia Neocaledonica* 3 Matile, L., Najt, J., and Tillier, S. (eds) *Mémoires du Muséum Nationale d'Histoire Naturelle* 157: 27–71.
- Scheller, U. 1994. Pauropoda of a secondary forest near the Tarumã Mirim River, Amazonas, Brazil (Myriapoda, Pauropoda, Pauropodidae). *Amazoniana* 13: 65–129.
- Scheller, U. 1997. Pauropoda from upland and inundation forests in Central Amazonia, Brazil (Myriapoda, Pauropoda: Millotauropodidae, Pauropodidae). *Amazoniana* 14: 223–300.
- Scheller, U. In prep. Descriptions of new Tasmanian Pauropoda.
- Silvestri, Ph. 1902. Ordo Pauropoda. P. 10 in: Berlese, A. (ed.), *Acari, Myriapoda et Scorpiones hucusque in Italia reperta*.
- Tiegs, O.W. 1943. A new species of *Pauropus* from Victoria. *Memoirs of the National Museum of Victoria* 13: 151–56.
- Tiegs, O.W. 1947. The development and affinities of the Pauropoda, based on a study of *Pauropus silvaticus*. *Quarterly Journal of Microscopical Science* 88: 165–267, 275–336.

Appendix 1

Species data on Arthropoda groups, excluding Pauropoda, from Tasmanian rainforests, included in this paper can be found on <http://www.museumvictoria.com.au/About/Books-and-Journals/Journals/Memoirs-of-Museum-Victoria>



APPENDIX 1. Species data on Arthropoda groups, excluding Pauropoda, from Tasmanian rainforests, included in this paper. Names have not been updated from those made in 1993/4

Identifications by Glen Hunt, specimens lodged in the Australian Museum.	Identifications by Alison Green, specimens lodged in the Tasmanian Museum and Art Gallery
Opiliones Acropsopilionidae	Isopoda Styloniscidae
<i>Austropsopilio cigneus</i> <i>Austropsopilio</i> sp. <i>Austropsopilio</i> sp. nov. <i>Tasmanopilio</i> sp. Triaenonychidae <i>Thelbunus</i> sp. nov. Gen.nov. sp. nov. <i>Ankylonuncia</i> sp. <i>Bryonuncus distincta</i> <i>Caliluncus</i> sp. <i>Caliluncus vulsus</i> <i>Chrestobunus</i> ? <i>fuscus</i> <i>Chrestobunus</i> sp. nov. <i>Glyptobunus</i> ? <i>signatus</i> <i>Lomanella atrolutea</i> <i>Lomanella raniceps</i> <i>Mestonia acris</i> <i>Mestonia</i> sp. ? <i>Miobunus</i> sp. <i>Nuncia silvestris</i> <i>Nunciella</i> sp. immature <i>Nuncioides</i> sp. <i>Odontonuncia</i> sp. <i>Phanerobunus</i> sp. <i>Phoxobunus tuberculatus</i> <i>Rhynochbunus arrogans</i> <i>Tasmobunus</i> ? <i>constans</i> <i>Tasmobunus</i> ? <i>parvus</i> <i>Tasmobunus</i> sp. <i>Thelbunus mirabilis</i> <i>Triaenobunus asper</i> <i>Triaenobunus pectinatus</i> Indet. Immature	 <i>Styloniscus nichollsi</i> <i>Styloniscus</i> sp. cf. <i>nichollsi</i> <i>Styloniscus maculosus</i> <i>Styloniscus</i> sp. cf. <i>maculosus</i> <i>Styloniscus squarrosus</i> <i>Styloniscus</i> sp. cf. <i>squarrosus</i> <i>Styloniscus hirsutus</i> <i>Styloniscus</i> sp. nr <i>hirsutus</i> <i>Styloniscus hirsutus</i> large form <i>Styloniscus sylvestris</i> <i>Styloniscus</i> sp. 2 (HEC survey) <i>Styloniscus</i> sp. 3 (HEC survey) <i>Styloniscus</i> sp. 4 (ABRS) <i>Styloniscus</i> sp. 5 (ABRS) <i>Styloniscus</i> sp. cf. 5 <i>Styloniscus</i> sp. large nr <i>planus</i> <i>Styloniscus</i> sp. immature <i>Notoniscus chiltoni</i> <i>Notoniscus</i> sp. (ABRS) Philosciidae <i>Plymophiloscia thomsoni</i> <i>Plymophiloscia notleyensis</i> <i>Plymophiloscia</i> cf. <i>tasmaniensis</i> <i>Plymophiloscia tasmaniensis</i> <i>Plymophiloscia</i> sp. 3 Trachelipidae sp. 1 sp. 2 Armadillidae <i>Cubaris tamarensis</i> Cubarinae sp. 1 Cubarinae sp. 2
Megalopsalididae <i>Spinicrus nigricans</i> <i>Spinicrus tasmanicum</i> <i>Spinicrus</i> sp. <i>Spinicrus</i> immature	

Amphipoda**(Identification by A. Friend)**

Ochestiella neambulans
Orchestiella quasimodo
Tasmanorchestia annulata
Tasmanorchestia sp. nov.
Austroides longcornis
Austroides leptomeris
Neorchestia plicibranchia
Mysticotalistris tasmaniae
Mysticotalistris cryptus
Keratrioides albidus
Keratrioides vulgaris
Keratrioides rex
Keratrioides pyrensis
Keratrioides angularis
Keratrioides sp. nov.
Architalitrus bassianus
Orchestia sp.

Specimens identified R. Mesibov, lodged in the Queen Victoria Museum

Diplopoda**Polyzoniida**

Siphonotidae

Siphonotus sp. nov. 1
Siphonotus sp. nov. 2
Siphonotus sp. nov. 3
 Gen. 1 nov, sp. nov. 1
 Gen. 2 nov. sp. nov. 1

Choreumatida

Peterjohnsiidae

Peterjohnsia titan

Metopidiotrichidae

Australeuma jeekeli
Australeuma simile
Australeuma sp. nov.
Schedotrigona tasmanica
Reginaterreuma tarkinensis
Neocambrisoma sp. nov.
 Gen. nov. sp. nov.

Spirostreptida

Lulumorphidae

Amastogonus nichollsii

Polydesmida

Paradoxosmatidae

Gen. nov sp. nov.

Daldodesmidae

Tasmanodesmus hardyi
Gasterogramma sp. nov. 5
Gasterogramma sp.
Lissodesmus adrianae
Lissodesmus perporosus
Lissodesmus sp. cf. *margaretae* E
Lissodesmus sp. cf. *margaretae* A
Lissodesmus sp. nov. E1
Lissodesmus sp. nov. NE1
Lissodesmus sp. nov. NW1
 Gen. nov. sp. nov.

Families uncertain

Gen. B. sp. 1
 Gen. B. sp. 2
 Gen. A. sp. 2

Oribatida**Euphthiracaroida**

Oribotritiidae

Oribotritia brevis
Oribotritia contortula
Oribotritia sp.
Indotritia breviseta

Euphthiracaridae

Microtritia contraria
Microtritia glabrata

Phthiracaroida

Phthiracaridae

Phthiracarus probus

Steganacaridae

Phonaphacarus aduncus
Hoplophthiracarus montigenus
Austrophthiracarus aculeatus
Austrophthiracarus dissonus
Austrophthiracarus egregius
Austrophthiracarus facetus
Austrophthiracarus hallidayi
Austrophthiracarus mutabilis
Austrophthiracarus perproquinqus
Austrophthiracarus pilosus
Austrophthiracarus scopoli
Austrophthiracarus selnicki
Notophthiracarus abstemius
Notophthiracarus admirabilis
Notophthiracarus alienus
Notophthiracarus comparativus
Notophthiracarus consimilis
Notophthiracarus flexilobus
Notophthiracarus indubitatus
Notophthiracarus schusteri
Notophthiracarus solitarius
Notophthiracarus sordidus
Notophthiracarus spurcus
Notophthiracarus uncinatus



Hydroids of the BANZARE expeditions, 1929 – 1931: the family Haleciidae (Hydrozoa, Leptothecata) from the Australian Antarctic Territory

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Abstract

Watson, J.E. 2008. Hydroids of the BANZARE expeditions, 1929 – 1931: the family Haleciidae (Hydrozoa, Leptothecata) from the Australian Antarctic Territory. *Memoirs of Museum Victoria* 65: 165–178.

The BANZARE Expeditions (British, Australian, New Zealand, Antarctic Research Expeditions) 1929 – 1931 sampled the marine benthos in the Southern Ocean, at the Kerguelen Islands, Heard Island, Macquarie Island, and south-west of Tasmania and along the coast of the Australian Antarctic Territory. Forty six stations at depths of 2 – 640 m were occupied along the Australian Antarctic Territory coast. Eight species of Halecium including five new and Hydrodendron arboreum were found and recorded from eight stations.

Keywords

BANZARE Expeditions (1929–1931), Australian Antarctic Territory, family Haleciidae.

Introduction

The BANZARE Expeditions (British, Australian, New Zealand, Antarctic Research Expeditions) 1929–1931, led by Sir Douglas Mawson, made major collections by dredgings from the research vessel *Discovery* in several geographical localities: the Southern Ocean from South Africa to Western Australia, the Kerguelen Islands, Heard Island, Macquarie Island, south-west of Tasmania and along the coast of the Australian Antarctic Territory.

Forty six stations were occupied along the Australian Antarctic Territory coast and samples collected using various trawls to depths 640 m; some coastal collections to were also made in shallow water 2 m deep. The hydroid collection was originally deposited in the British Museum, Natural History (BMNH), London. There, preserved material was sorted during the 1960s and microslide mounts prepared. A small amount of material left over from the earlier AAE (Australian Antarctic Expedition) 1911–1914 was also incorporated into the BANZARE collection as Station No. 1785 (see Table 1).

The entire BANZARE hydroid collection comprises more than 200 jars and vials of preserved material and some 1500 microslides. For ease of study the collection was divided into the major geographical localities mentioned above. The Antarctic part of the collection comprises some 32 jars of bulk samples, 83 tubes of preserved material and some 250 microslide preparations. Samples were originally provided with a BANZARE field station number (eg. Station 105) by the expedition and later at the BMNH a reference number was added (eg. Station 105, BMNH Hydr. No. 711/6). A few provisional identifications were made at the time by Dr W. J. Rees in the BMNH but no reports were prepared. In 1970s the entire BANZARE hydroid collection was

sent to the National Museum of Victoria (now Museum Victoria) in Melbourne for identification. A difficulty arising from the BMNH reference numbering system has been determining whether several microslides from the same station but labelled with different BMNH reference numbers are from the same, or from different colonies. As no information on allocation of reference numbers was provided by the BMNH, it is assumed in this report that species with consecutive reference numbers but under the same station number relate to the same colony. To reduce confusion the BMNH reference numbers have thus been abandoned and the material described in this report is provided with a Museum Victoria registration number (NMV F).

Some of the preserved material is now fragile; furthermore, many of the microslides prepared by the BMNH were treated with a stain which, over the years, has darkened to almost opaque green. Re-mounting of this opaque material has not been undertaken being too time-consuming and likely to destroy already fragile specimens. For this study descriptions have been made from those BMNH microslides in good condition and from preserved material in temporary glycerol mounts and stained with Bengal Rose.

This paper examines the Antarctic Family Haleciidae collected from the coast of the Australian Antarctic Territory. Eight species of *Halecium* (including five new) and one species of *Hydrodendron* are described. The greatest number of records of the Haleciidae were from stations off Princess Elizabeth Land from 60°–80°E (Figure 1, Table 1). The most abundant species in the collection were *Halecium banzare* sp. nov. and *Hydrodendron arboreum*, each of which occurred at four stations, followed by *Halecium delicatulum*, recorded from three stations. All other species were recovered from only one or two stations.

Table 1. Station Records of Haleciidae

Station No.	Lat. South	Long. East	Depth m	Dredge type	Remarks in <i>Discovery's Log</i>
34	66° 21'	58° 50'	603	DRL	No information
40	66° 12'	49° 37'	300	TML	Good haul
41	65° 48'	53° 16'	209	TML	Abundant haul; heavy pack ice
88	67° 00'	142° 36'	4 - 13	DRS	Commonwealth Bay; among kelp
97	65° 10'	108° 12'	474	DRL	No information
98	65° 07'	107° 29'	502	DRL	No information
103	67° 03'	74° 29'	437	DRL	No information
105	67° 46'	67° 03'	163	DRL	Near glacier, MacRobertson Land
107	66° 45'	62° 03'	210	DRL	Adjacent to large Icebergs
1785 ¹	-	-	45	unknown	No information

Note 1: Station 1785 was occupied in Commonwealth Bay during the Australian Antarctic Expedition, 1911 - 1914. Station 88 was occupied at Cape Denison in Commonwealth Bay during the 1931 part of the BANZARE expedition.

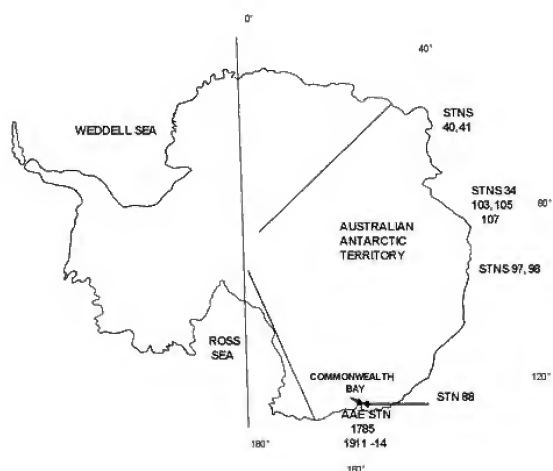


Figure 1. Map of the Antarctic showing BANZARE stations from which *Halecium* is recorded, station 1785, Commonwealth Bay, from the AAE 1911 - 1914 expedition.

Family Haleciidae Hincks, 1868

Thecate hydroids with shallow, saucer- or basin-shaped hydrothecae. Hydrotheca radially symmetrical, usually with diaphragm; margin entire, without operculum. Hydranth large and usually not completely retractable into hydrotheca, with conical hypostome and one circlet of filiform tentacles. Nematophores present or absent. Gonophores in form of fixed sporosacs or rarely, freed as medusae.

Halecium antarcticum Vanhöffen, 1910

Figure 2A–C

Halecium antarcticum Vanhöffen, 1910: 317, fig. 34.- Billard, 1914: 7, fig. 5.- Totton, 1930: 144, fig. 4.- Broch, 1948, 28: 7.- Naumov and Stepanjants, 1958: 57.- Blanco, 1984: 294, figs 8-13, pls. 4-5.

Material examined. NMV F147447, Station 107, two microslides displaying branch fragments and a preserved fertile colony. NMV F147448, Station 107, one microslide displaying branch fragments. NMV F147449, Station 1785, one microslide displaying two small branch fragments.

Description. Fertile colony originally at least 40 mm high. Hydorhiza reptant on sponge; stolons tubular, rugose, loosely adherent to substrate.

Shorter stems monosiphonic; stems beginning with several broad basal annulations above junction with hydorhiza; taller stem branched, lightly fascicled with several wide, tangled tubes running almost to tip of colony and along primary branches. Branching irregular and disorderly, branches bent outwards at various angles from main stem, ultimate branches short, straight, monosiphonic. Monosiphonic branch internodes fairly wide, cylindrical, walls smooth, nodes deep, oblique, sloping away from hydrophore, a tumescence and often one or several deep corrugations in perisarc above node.

Primary hydrophores alternate on stem, one distal on each internode, cylindrical, length variable but typically moderately long, abcauline wall curving smoothly away from internode, adcauline wall more or less straight. Hydrotheca bowl-shaped, expanding from diaphragm to margin, rim everted and a little outrolled. Diaphragm fairly distinct, a few desmocytes above.

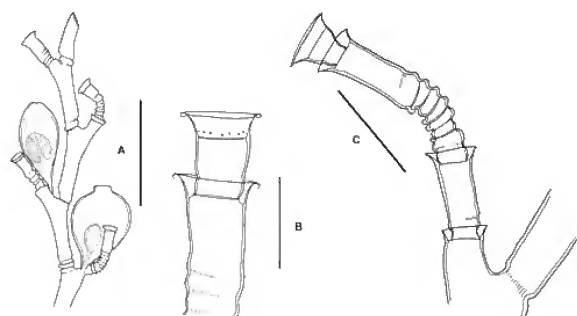


Figure 2. A - C. *Halecium antarcticum* from Station 107. A, fertile branch with well defined internodes and mature and developing gonothecae. B, hydrophores and hydrothecae with desmocytes. C, branch with linear regeneration of hydrophores. Scale bar: A, 2 mm; B, 0.3 mm; C, 0.5 mm.

Hydrophores typically regenerated in linear series of up to five; successive hydrophores variable in length, each arising from diaphragm of preceding hydrotheca; hydrophores with broad basal kinks and up to 10 close corrugations.

Gonothecae probably male, inserted in hydrophore on distal monosiphonic branches; shape variable from flattened clavate to ovoid with a low apical dome with flattened top.

Perisarc of stem, branches and hydrothecae rather thick, very thin on gonothecae.

Colour (preserved material) deep honey brown, paler on monosiphonic branches; gonotheca colourless.

Measurements (μm)

Branch internode	
length	419 – 514
width at node	176 – 216
Hydrophore	
length to diaphragm, adcauline wall	196 – 274
Hydrotheca	
depth, margin to diaphragm	71 – 87
diameter at margin	277 – 316
diameter at diaphragm	174 – 237
Gonotheca	
length	1,176 – 1,568
maximum width	882 – 910

Remarks. The taller stem is notable for its untidy habit of growth and thickening of the polysiphonic tubes at origin of the primary branches. Several short monosiphonic branches are incipiently anastomosed, two showing reversal of growth so that the hydrophores now face backwards towards the stem.

The gonothecal perisarc is very fragile, few being

undamaged, only two showing a flattened apex. As only the spadix and some tissue remains in most gonothecae, sex could not be determined.

As dimensions of the present material fit reasonably well with Vanhöffen's (1910) and Totton's (1930) descriptions of *Halecium antarcticum*, the material is assigned to this species.

Distribution. *Halecium antarcticum* is recorded from depths of 256 m in McMurdo Sound, 290 m in the Ross Sea and 385 m at Gauss Station.

Halecium banzare sp. nov.

Figure 3A-F

Holotype NMV F147450, Station 41, three microslides displaying branch fragments; also preserved male colony. *Paratypes* NMV F147451, Station 34, one microslide displaying one branch. NMV F147452, Station 107, one microslide displaying small branch fragment; preserved fragmented female stem or branch 70 mm long. NMV F147479, Station 107, one microslide displaying small branch fragment. NMV F147455, Station 107, two microslides displaying branch fragments; a small fragmented preserved colony. NMV F147479, one microslide displaying small branch fragment.

Diagnosis. Colonies originally 80 - 140 mm high, the tallest stem arising from a tufted hydrorhiza of thin, tangled, shining stolons. Stem thick, brittle, branched, heavily fascicled; polysiphonic tubes parallel, running almost to top of stem, along primary branches and along some secondary branches. Primary branches long, held out stiffly more or less in plane almost perpendicular to stem, succeeding branches in three or four orders; new branches given off from a hydrophore or from within a hydrotheca, typically long, monosiphonic, thin and flaccid with one to three deep basal annulations. Monosiphonic branch internodes moderately long, cylindrical, walls smooth, widening distally to hydrophore, nodes deeply indented, oblique to transverse, typically one or two constrictions above and below node.

Hydrophores alternate, distal on internode and directed outwards, projecting above level of node, walls cylindrical, smooth, abcauline wall often faintly bulging, adcauline wall slightly concave, often an internal thickening in perisarc about two thirds distance up wall, joining abcauline wall with a faint diagonal line in perisarc. Hydrotheca shallow, expanding a little from diaphragm to margin; rim circular, weakly everted. Diaphragm distinct, transverse, a row of desmocytes just above. Secondary hydrophores common, arising from diaphragm of hydrotheca, a transverse constriction in perisarc of secondary hydrophore just above rim of hydrotheca.

Gonothecae of both sexes inverted conical, compressed, borne prolifically on younger branches, inserted without distinct pedicel in wall of hydrophore or lower down on internode; male gonotheca with a minute apical peak (visible only in side view), female similar in shape to male, gonophore containing large scattered ova; gonophores of both sexes with an apical pad of tissue. No visible aperture in either sex.

Perisarc of fascicled stem and branches firm, thinner on monosiphonic branches, very thin on gonotheca.

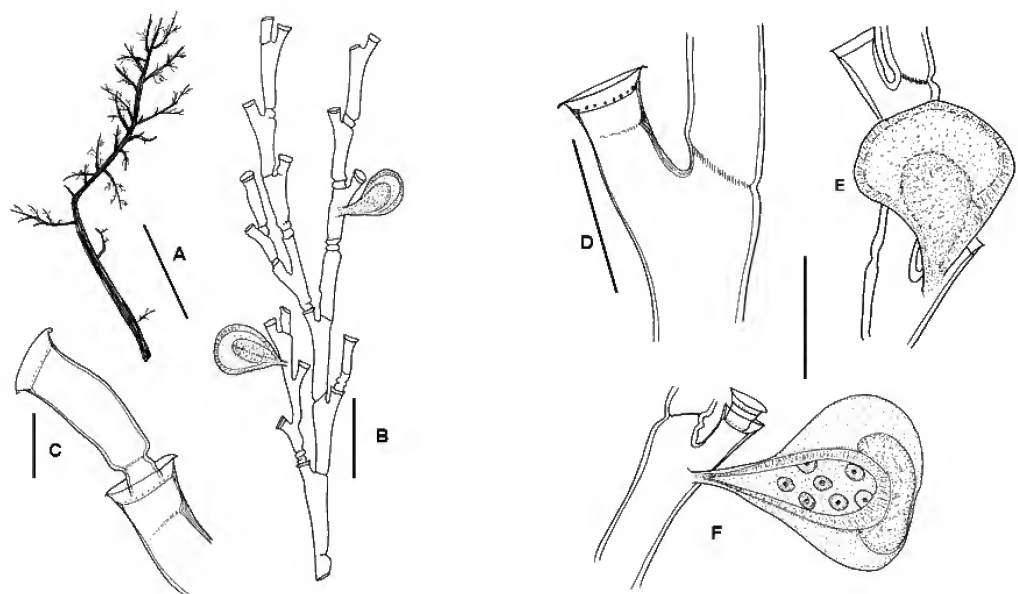


Figure 3. A - F. *Halecium banzare* sp. nov. A, branch from holotype. B, part of branch from holotype. C, D, hydrophores from paratype. E, male gonotheca from holotype. F, (NMVF 147452) female gonotheca. Scale bar: A, 50 mm. B, 1 mm. C, 0.3 mm. D-F, 0.5 mm.

Colour of lower stem pale honey-brown, becoming paler distally, apex of stem and monosiphonic branches colourless.

Measurements (µm)

Branch internode	
length	706 – 882
width at node	113 – 176
Hydrophore	
length of adcauline wall of primary to diaphragm	150 – 183
Hydrotheca	
depth, diaphragm to margin	39 – 47
diameter at rim	137 – 164
width at diaphragm	125 – 140
Gonotheca	
length	1,027
maximum width	948

Remarks. Although now much fragmented, the colonies were probably tall and sparsely branched, arising from a thick, matted hydrorhiza. Internal thickening of the perisarc is present in many hydrophores. The ova are scattered, not clustered around the spadix of the gonophore. Both sexes appear to be near maturity but as none of the gonothecae show any sign of an aperture it seems likely that reproductive material is released by rupture of the very thin perisarc.

The outwardly directed hydrophores and hydrothecae are structurally similar to those of *Halecium antarcticum* Vanhöffen (1910). However, according to Totton (1930), colonies of that species from McMurdo Sound were only 30 mm high, straggling, lightly fascicled, and with anastomoses, unlike the robust habit of *H. banzare*. A further important distinction is the much shallower hydrotheca in *H. banzare* which is only half as deep as that of *H. antarcticum*.

Etymology. The species name commemorates the BANZARE expedition.

Halecium brevithecum sp. nov.

Figure 4A-C

Holotype NMV F147457, Station 41, one microslide displaying three branch fragments. *Paratypes*, NMV F147458, Station 40, one microslide displaying two branch fragments. NMV F147478, Station 98, one microslide displaying one branch fragment; some preserved material.

Diagnosis. Infertile stem or branch fragments of a presumably larger colony. Stem (branch) fascicled, polysiphonic tubes varying from knotted to parallel. Branching irregular, ultimate branches monosiphonic, given off from side of a hydrophore; branches beginning with three to five deeply indented transverse nodes, internodes thereafter moderately long, walls smooth, abaxial wall expanding smoothly into hydrophore; nodes transverse to weakly oblique, deeply incised into perisarc, a faint tumescence in internode above and below node.

Hydrophores indistinct, adcaudal wall adnate to internode, becoming free (although this scarcely visible) just below hydrotheca. Hydrotheca distal on internode, adcaudal wall adnate to internode; margin tilted at an obtuse angle away from internode; hydrotheca very shallow, expanding imperceptibly to rim; rim not quite reaching node, walls of hydrotheca thin; diaphragm transverse, strong. No marginal replications or linear series of hydrophores.

Gonotheca absent.

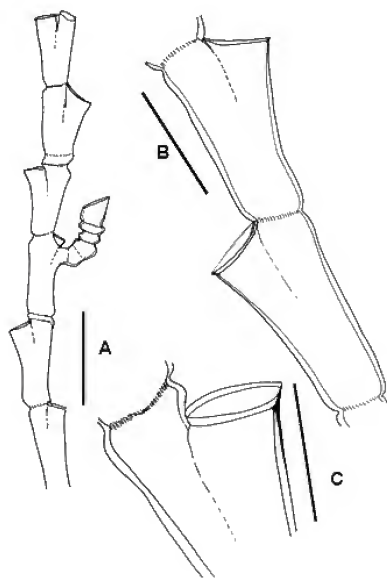


Figure 4. A - C. *Halecium brevithecum* sp. nov. *Holotype*. A, branch. B, branch internodes. C, hydrophore and shallow hydrotheca. Scale bar: A, 1 mm, B, 0.5 mm. C, 0.3 mm.

Measurements (μm)

Monosiphonic branch internode	
length	520 - 800
width at node	200 - 240
Hydrophore, length	220 - 240
Hydrotheca	
diameter at margin	220 - 240
depth, diaphragm to margin	20 - 32

Remarks. Unfortunately the material is meagre and infertile and the permanently mounted specimens poorly displayed. The species is remarkable for the shallowness of the hydrotheca which provides minimal support for the hydranth. There is indication of desmocytes above the diaphragm but the interior of most hydrothecae is obscured by tissue and adventitious material. There is an indication of incipient anastomosing of the ultimate branches.

Species with very shallow adnate hydrothecae considered were: *Halecium beanii* (Johnston, 1838), *Halecium sessile* Norman, 1866, *Halecium ralphae* Watson and Vervoort, 2001 and *Halecium* sp. 1 Vervoort and Watson, 2003. The diameter of the hydrotheca of *Halecium brevithecum* is, however, greater than in these species.

Etymology. The species is named for the remarkably short hydrotheca.

Halecium delicatulum Coughtrey, 1876

Figure 5A-B

Halecium delicatulum Coughtrey, 1876a: 299.- Coughtrey 1876b: 26, pl. 3, figs 4-5.- Stechow, 1913a: 144.- Stechow, 1913b: 9, 79.- Stechow, 1923b: 5.- Bale, 1924: 235.- Ralph, 1958: 334, figs 11e, h-n, 12 a-p.- Pennycuik, 1959: 173.- Yamada, 1959: 31.- Leloup, 1960: 218, fig. 1.- Naumov and Stepanjants, 1962: 94, figs 16-17.- Rees and Thursfield, 1965: 106.- Millard, 1966a: 464, fig. 10L.- Ralph, 1966: 158.- Blanco, 1968: 203, pl. 1, figs 14-18, pl. 2, figs 1-3.- Millard, 1968: 253, 256.- Day *et al.*, 1970: 12.- Patrity, 1970: 23, fig. 21.- Blanco and Bellusci de Miralles, 1972: 7, figs 3-5.- Naumov and Stepanjants, 1972: 34, 52.- Stepanjants, 1972: 72.- Vervoort, 1972a: 27, figs 4-5.- Vervoort, 1972b: 341, fig. 2a.- Morton and Miller, 1973: 152, fig. 54.10.- Watson, 1973: 166.- Leloup, 1974: 10.- Millard, 1975: 145, fig. 47F-L.- Watson, 1975: 159.- Gordon and Ballantine, 1977: 100.- Millard, 1977a: 7, fig. 1C-D.- Stepanjants, 1979: 105, pl. 20, fig. 4A-V.- Watson, 1979: 234.- Hirohito, 1983: 5, 11.- Rho and Park, 1983: 41, pl. 2, figs 1-3.- Blanco, 1984c: 262, figs 1-6.- Blanco 1984d: 271, figs 3-5.- Rees and Vervoort, 1987: 25, fig. 5.- Staples and Watson, 1987: 218.- Ramil, Blanco and Iglesias Diaz, 1988: 72, fig. 2.- Gili *et al.*, 1989: 78, fig. 7B.- Altuna and García Carrascosa, 1990: 54 *et seq.*- Genzano, 1990: 38, figs 2-5.- El Beshbeeshy, 1991: 32, figs 4a, 4b.- Park, 1991: 544.- Roca *et al.*, 1991: 70.- Genzano and Zamponi, 1992: 40, fig. 17.- Park, 1992: 286.- Ramil and Vervoort, 1992a: 82, fig. 20a-c.- Branch and Williams, 1993: 11.- Watson, 1994a: 66.- Altuna Prados, 1995: 54.- Bouillon *et al.*, 1995: 45.- Hirohito, 1995: 20, text-fig. 5a-c, pl. 1, fig. C.- Park, 1995: 10.- Genzano, 1996a: 290 *et seq.*- Medel and Vervoort, 2000: 12 (*cum syn.*)- Vervoort and Watson, 2003: 88, fig. 16 A-E.

Halecium flexile Allman, 1888: 11, pl. 5, figs 2, 2a.

Halecium gracile Bale, 1888: 759, pl. 14, figs 1–3 (not *Halecium gracile* Verrill, 1873: 729).

Halecium parvulum Bale, 1888: 760, pl. 14, figs 4–5.

Material examined. NMV F147459, Station 97, one microslide displaying a branch fragment; some preserved material. NMV F147460 Station 98, one microslide displaying two branches. NMV F147461, Station 103, eleven microslides displaying branches from male colony; some preserved material. NMV F14762, Station 107, one microslide displaying a branch. NMV F147477, two microslides displaying branch fragments.

Description. Stems to 10 mm long, taller stems fascicled, arising from tangled tubular hydrorhizal stolons. Younger stems monosiphonic, flexuous. Basal cauline internodes with several deep proximal corrugations, internodes thereafter smoother, long, cylindrical, tending to become sympodial in older stems; nodes distinct, oblique to transverse, one to three shallow annulations in perisarc above and below node. Hydrophores alternate, one distal on each primary cauline internode sloping outwards from node, contiguous with direction of internode; hydrophores variable in length, walls cylindrical, smooth; branches when present, given off from below primary hydrophore.

Hydrothecae moderately deep, walls outwardly curved, margin circular, wide, rim strongly outrolled; margins not replicated. Diaphragm distinct, transverse to shallow funnel-shaped, usually a distinct row of desmocytes above.

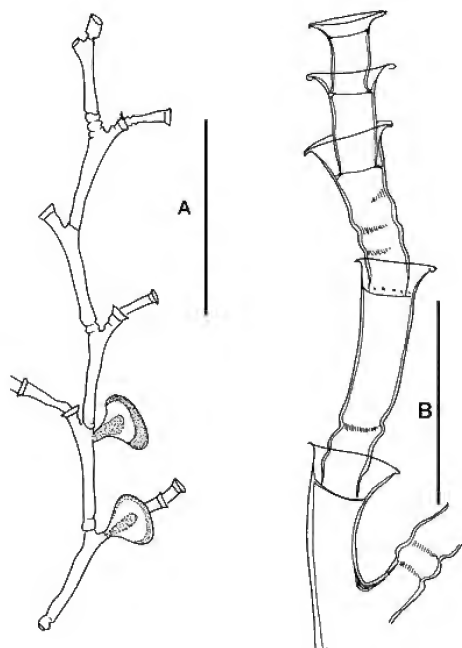


Figure 5. A - B. *Halecium delicatulum*. A, fertile branch with developing gonothecae. B, hydrophores in linear series. Scale bar: A, 2 mm. B, 0.3 mm.

Hydrophores arising up to five linear in series; variable in length, each arising from diaphragm of preceding hydrotheca, typically becoming shorter along the series; proximal walls of younger hydrophores often weakly undulated.

Colonies dioecious; gonotheca inserted without distinct pedicel in internode or hydrophore; immature gonothecae of both sexes balloon-shaped, compressed, developing gonophores in all samples immature, surmounted by an apical pad of tissue.

Hydranth with c. 24 tentacles.

Perisarc of stems moderately thick, thinner on gonothecae.

Measurements (µm)

Internode	
length	941 – 1,078
width at node	74 – 111
Hydrophore	
length (abcauline) of primary	198 – 988
length of succeeding hydrophores	78 – 387
Hydrotheca	
depth, margin to diaphragm	43 – 82
diameter at margin	179 – 211
diameter of diaphragm	94 – 129
Gonotheca	
Length	537 – 672
Apical (maximum) width	435 – 577

Remarks. The gonophores in most samples are immature, those on only one stem showing developing ova.

Distribution. Circumglobal in tropical, subtropical, and boreal waters. Recorded at all depths to 2,250 m. It is sometimes considered conspecific with *Halecium antarcticum* Vanhöffen, 1910, and with *H. mediterraneum* Weismann, 1883, the former reported from isolated Antarctic localities and the latter from many Mediterranean Sea localities (Vervoort and Watson 2003). Such wide latitudinal and bathymetric distribution may indicate that several morphologically similar species are possibly lumped together as *H. delicatulum*.

Halecium elegantulum sp. nov.

Figure 6A-C

Holotype NMV F147463, Station 103, two microslides displaying several infertile stems. **Paratypes** NMV F147464, Station 103, two microslides displaying stems. NMV F147476, Station 103, one microslide displaying a small colony. All material probably from same colony on sertulariid hydroid.

Diagnosis. Stems arising from a creeping hydrorhiza; stolons tubular, smooth to crumpled. Hydrocaulus minute, variable in length, simple, unbranched, walls cylindrical, narrow, smooth, without nodes but with occasional shallow constrictions

marking zones of regrowth after breakage. Hydrocaulus with either a single terminal hydrotheca or a linear series of up to six hydrophores each arising from diaphragm of preceding hydrotheca; base of hydrophore swollen above supporting diaphragm.

Hydrotheca moderately deep, trumpet-shaped, expanding strongly from diaphragm to margin; rim circular, weakly outrolled; no replication of margin. Diaphragm delicate, transverse to concave, no desmocytes visible.

Perisarc thickest in proximal stem region, thinning distally; very thin on hydrotheca.

Gonotheca absent.

Measurements (µm)

Hydrocaulus	
length overall	1,764 – 4,840
length of basal segment to node	1,372 – 4,840
length of succeeding hydrophores	95 – 593
diameter of hydrophore	43 – 70
Hydrotheca	
diameter at diaphragm	59 – 78
depth rim to diaphragm	20 – 28
diameter at margin	113 – 117

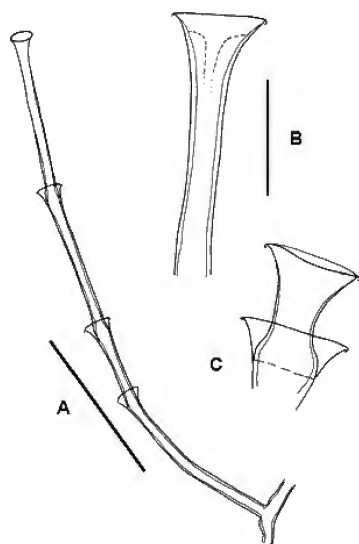


Figure 6. A - C. *Halecium elegantulum* sp. nov. NMV F147463, holotype. A, whole stem. B, hydrophore. C, replicated hydrothecae. Scale bar: A, 0.5 mm. B, C, 0.1 mm.

Remarks. As there are few clearly visible diaphragms and concave pseudo-diaphragms are visible in some hydrothecae. In most instances the depth from rim to diaphragm has been estimated as the distance from the base of secondary hydrophores to the rim of the supporting hydrotheca.

The few remaining hydranths are too decomposed for description but seem to have been very long and extensile. No desmocytes were seen but the interior of most hydrothecae is obscured by adventitious matter.

Two small, closely related species were considered: *Halecium tenellum* Hincks, 1861 and *Halecium fragile* Hodgson, 1950. Although most measurements of *Halecium elegantulum* fall within the range given by Cornelius (1995) for *H. tenellum* from the North Atlantic and by Watson (2003) for *H. tenellum* from the subantarctic, both of these species are branched whereas all material of *H. elegantulum* is unbranched showing no evidence of branching. Furthermore, the hydrotheca of *H. elegantulum* is elongated, not shallow as in *H. fragile*.

Etymology. The name refers to the elegantly simple hydrocaulus.

Halecium interpolatum Ritchie, 1907

Figure 7A, B

Halecium interpolatum Ritchie, 1907: 526, pl. 1, fig 3, pl. 2, fig. 3.- Rees and Thursfield, 1965: 107, 197.- Smaldon *et al*, 1976: 17.- Stepanjants, 1979: 103, pl. 16, fig. 7.- Blanco, 1994a:156.- Blanco, 1994b: 186.

Material examined. NMV F147466, Station 88, two microslides displaying small branch fragments; a preserved male colony.

Description. Colonies branched, reaching a height of 30 mm. Hydromorpha a mass of corrugated tubular stolons. Stems fascicled, lower stem region a loose aggregation of, stolons becoming polysiphonic tubes, passing along lower branches to mid-region of colony; stems thereafter profusely and irregularly branched.

Younger branches monosiphonic, typically a single branch given off from a geniculation of hydrophore below a hydrotheca, sometimes a second branch given off on opposite side of hydrophore; branches rugose to deeply corrugated and jointed but lacking true nodes; joints transverse to weakly oblique. Hydrophores variable in length, often corrugated, typically a short more or less smooth segment below hydrotheca.

Hydrotheca deep bowl-shaped, expanding strongly from diaphragm to margin; margin circular, rim strongly outrolled. Diaphragm distinct, some secondary and succeeding hydrophores arising in a linear series from diaphragm of preceding hydrotheca; hydrophores fairly short, typically deeply corrugated.

Hydranths with c. 20 – 24 rather stubby tentacles, not well preserved.

Male gonotheca ovoid to balloon-shaped, flattened, inserted on a very short narrow pedicel in an axil or in a hydrotheca, a minute apical protuberance visible in some gonothecae. Gonophores near maturity, almost filling cavity of gonotheca.

Perisarc of stems and branches very thick, thinner on hydrotheca and gonotheca.

Colour (preserved material), pale honey brown, youngest branches yellowish, gonophores darker brown.

Measurements (μm)

Branch	
distance between hydrothecae on branch	745 – 1470
width of smooth section of branch	134 – 158
Hydrotheca	
diameter at diaphragm	134 – 150
diameter at margin	269 – 300
depth, margin to diaphragm	95 – 134
Gonotheca	
length, including pedicel	869 – 909
maximum width	474 – 553

Remarks. Ritchie's material of *H. interpolatum* was infertile, his description was general and lacked important dimensions.

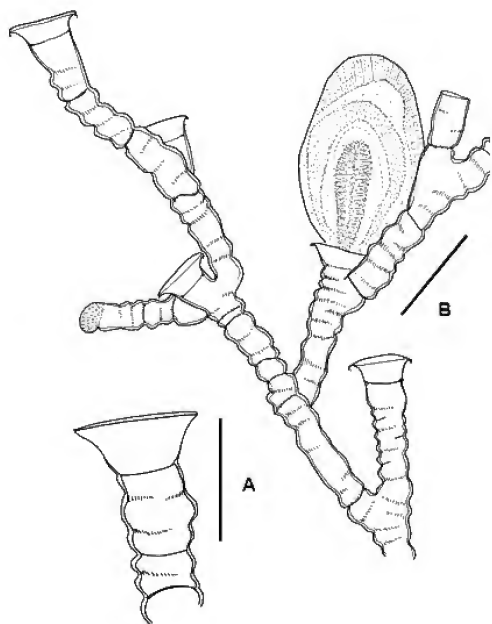


Figure 7. A, B. *Halecium interpolatum*. A, fertile monosiphonic branch with nearly mature male gonotheca. B, hydrotheca. Scale bar: A, 0.3 mm. B, 0.5 mm.

In many respects the present material falls within the range of dimensions of *H. ovatum* Totton, 1930 and measurements deduced from Ritchie's description. Although the hydrocauli of the two species are superficially alike, the ovoid to quadrangular gonotheca of *H. ovatum* is considerably smaller than the lenticular gonotheca of *H. interpolatum*. I therefore assign the present material to *H. interpolatum*.

Distribution. South Orkneys. This is the first record of the species from Antarctica.

Halecium ovatum Totton, 1930

Figure 8A, B

Halecium ovatum Totton, 1930: 143, fig. 3.- Vervoort, 1972: 339, fig. 1.- Stepanjants, 1979: 103, pl. 20 fig. 1a-g.- Peña Cantero, 1991: 48, pl. 2, figs g-h.- Blanco, 1994: 160: 156.- Blanco, 1994: 187.- Peña Cantero and García Carrascosa, 1996: 12, fig. 2G-H.- Peña Cantero and García Carrascosa, 1999: 63: 212 *et seq.*- Watson, 2003: 166, fig. 15 D,E.- Vervoort and Watson, 2003: 86.

Notes and supplementary description from holotype. To establish the identity of *Halecium interpolatum* it became necessary to examine type material of *Halecium ovatum*. Although Totton provided an adequate description and dimensions of *Halecium ovatum* his figures were poor, and the gonotheca was not figured. I have compared the BANZARE material with the holotype (alcohol-preserved colony) and four paratype microslide preparations of *Halecium ovatum* loaned by the Natural History Museum, London. A brief supplementary description of the important diagnostic characters from the holotype (glycerol-mounted) of *Halecium ovatum* is given.

The holotype colony (BMNH No.29.10.10.1) comprises a dense tuft of long and short stems growing on another hydroid. Hydrocauli arise from a tangled adherent meshwork of tubular stolons entwined with hydrorhizae of the other hydroid.

Shorter stems monosiphonic, taller stems fascicled with up to 10 polysiphonic tubes; stems arborescently branched in all directions up to two thirds of their length, ultimate branches monosiphonic.

Mature female gonothecae small, borne abundantly on all but distalmost branches, inserted on a short pedicel in a hydrotheca typically situated in a fork between two or three branches but hydrotheca often overgrown by polysiphonic tubes; body of gonotheca ovoid to subquadrangular with a very thin, smooth perisarc; aperture terminal, small, circular, surrounded by a very low fragile collar; immature gonotheca kidney-shaped as described by Totton.

Nematocysts in tentacles undischarged ? anisorhizae capsule oval, 11–12 x 6–7 μm .

Measurements (μm) of gonotheca of *Halecium ovatum*

Length of pedicel of gonotheca	80
Length of gonotheca	784 – 1176
Width of gonotheca	588 – 901
Diameter of orifice	80

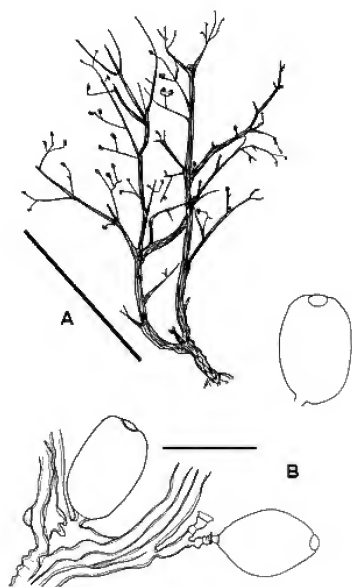


Figure 8. A, B. *Halecium ovatum*, holotype colony, BMNH Reg. No. 29.10.10.1. A, part of stem. B, empty female ovoid and subquadrate gonothecae. Scale bar: A, 10 mm. B, 1 mm.

Halecium macrocaulus sp. nov.

Figure 9A-F

Holotype NMV F147467, Station 107, one microslide displaying a branch; also a large preserved fragmented colony. **Paratypes** NMV F147468, Station 107, one microslide displaying two branch fragments. NMV F147469, Station 107, two microslides displaying branch fragments.

Diagnosis. Thickest fragments (stem or major branches) 6 mm wide at base and 200 mm long; branching profuse and irregular, originally all around stem. Stem and branches heavily fascicled by numerous thin, almost parallel tubes; tubes becoming fewer on younger branches, ultimate branches (hydrocladia) monosiphonic; several monosiphonic branches also given off from lower fascicled stem region. Branching sub-dichotomous, forks arising from within a hydrotheca; base of branch typically heavily corrugated, walls becoming smooth distally.

Ultimate branches straight, flaccid, internodes fairly short, walls smooth, nodes oblique, tilted away from hydrotheca, wall of internode expanding distally to accommodate hydrophore; hydrophore short, cylindrical, very close but not adnate to internode.

Hydrotheca shallow, adcauline wall closely adpressed to internode; walls expanding only slightly from diaphragm to margin; rim circular, tilted at $50 - 55^\circ$ to axis of internode, very weakly everted. Diaphragm distinct, a row of minute thorn-shaped desmocytes closely above; a septum (false

diaphragm) of perisarc passing diagonally through hydrophore from near junction of diaphragm with abcauline wall to adcauline wall.

Hydranths large with c. 24 tentacles, poorly preserved.

Secondary hydrophores rare but when present, arising from diaphragm of hydrotheca; hydrophore typically becoming a new branch beginning with two to four deep irregular twists, increasing in number with age to 10 deep corrugations.

Gonothecae abundant on monosiphonic branches, inserted without distinct pedicel on hydrophore or in hydrotheca; gonotheca sub-ovoid to almost triangular, strongly compressed, apex with minute twin peaks and no apparent aperture; gonophore oval, with clearly defined central spadix and apical pad of tissue armed with an array of large nematocysts.

Nematocysts of two morphological categories, none discharged:

- large bean-shaped isorhizas, $19-24 \times 7-9 \mu\text{m}$, abundant in apical pad of gonophore and throughout coenosarc of branches.
- leaf-shaped nematocysts (category indeterminate) in tentacles, $8 \times 2 \mu\text{m}$.

Perisarc of hydrocladia, hydrothecae and gonothecae very thin; thicker and robust in older parts of colony.

Colour of thickest branches (preserved material) dark brown fading to honey brown in younger parts, monosiphonic branches pale creamy white to transparent, gonophores brown.

Measurements (μm)

Monosiphonic branch	
length of apophysis, abcauline side	237 – 395
length of proximal (corrugated) internode	882 – 1,568
length of succeeding (hydrophorate) internodes	703 – 798
width at node	182 – 237
Hydrotheca	
diameter at diaphragm	198 – 221
depth, margin to diaphragm	59 – 66
diameter at margin	215 – 254
Gonotheca	
length overall	882 – 1,431
maximum width	588 – 1,078

Remarks. It is uncertain whether the material originally consisted of a large colony, now broken, or several smaller colonies. Despite the apparent robustness of the colony the hydrocladial perisarc is very thin, possibly having deteriorated during preservation.

The adcauline wall of the hydrotheca is so closely adpressed to the internode that the gap is only obvious on close

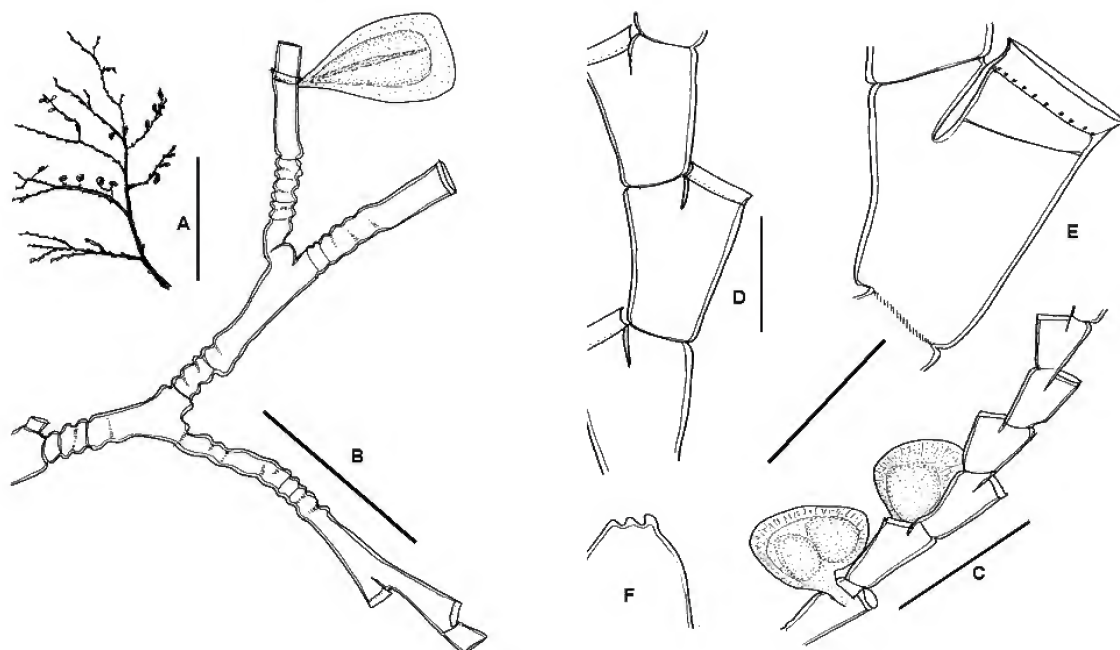


Figure 9. A – F. *Halecium macrocaulus* sp. nov. from holotype and paratype. A. fertile branch. B. monosiphonic part of branch with gonotheca. C, D, branch internodes. E, hydrotheca with false diaphragm and desmocytes. F, view of gonotheca showing apical protuberances. Scale bar: A, 15 mm. B, 2 mm. C, D, 0.5 mm. E, F, 0.3 mm.

examination. A diagonal septum (false diaphragm) below the transverse diaphragm occurs in many hydrothecae; it is usually obscured by tissue and visible only in cleared mounts. The desmocytes are also difficult to see, being very small and set close to the diaphragm. No replication of hydrothecae was found.

The numerous gonothecae are quite small compared with the size of the colonies. The gonophore almost fills the gonotheca, suggesting near-maturity. As there is no evidence of an aperture, the contents are probably released by rupture of the very thin perisarc. The nematocysts are abundant in the apical pad above the gonophore and in the coenosarc of the colony; they are very large and visible even at low magnification.

Large arborescent species of *Halecium* with closely adpressed hydrophores considered were: *Halecium beanii* (Johnston, 1838), *Halecium halecinum* (Linnaeus, 1758), *Halecium sessile* Norman, 1867 and *Halecium jaederholmi* Vervoort, 1972. *H. beanii* was rejected because the colonies and hydrothecal dimensions are smaller than those of *Halecium macrocaulus*; *H. halecinum* and *H. sessile* were discounted because of differences in colony morphology. Vervoort's (1972) description of *H. jaederholmi* is of a much smaller species with completely adnate and deeper hydrothecae.

Etymology. The species is named for the large size of the colony.

Halecium tubatum sp. nov.

Figure 10A, B

Holotype, NMV F147470, Station 105, three microslides displaying several stems. **Paratypes** NMV F147471, Station 105, four microslides displaying colony. NMV F147472, one microslide displaying colony. NMV F 147477, Station 98, one microslide displaying colony. NMV F147480, Station 90, one microslide displaying colony. NMV F147481, Station 107, one microslide displaying colony.

Diagnosis. Hydrorhiza reptant on hydroid host, stolons thin, tubular, rugose to smooth. Hydrocauli fragile, variable in length, to 4 mm, unbranched; hydrocaulus above hydrorhiza weakly rugose or with up to four deep annulations; hydrocaulus (pedicel) thereafter cylindrical, straight or weakly curved, walls smooth.

Pedicel bearing a single terminal hydrotheca; hydrotheca wide, bowl-shaped, walls flaring markedly from diaphragm to rim; rim circular, smooth, strongly outrolled, a row of desmocytes about halfway between diaphragm and rim. A few secondary and succeeding hydrophores in linear row from

diaphragm of hydrothecae; hydrophores widening to hydrotheca, a tumescence in perisarc above base.

Hydranths too few and too poorly preserved for description but possibly c. 20 tentacles.

Perisarc moderately thin throughout.

Gonotheca absent.

Measurements (µm)

Hydrorhiza	
width	72 – 82
Hydrocaulus	
length	900 – 2,200
diameter	68 – 80
Hydrotheca	
depth, margin to diaphragm	80 – 88
diameter at diaphragm	72 – 92
diameter at rim	220 – 300

Remarks. Although the sample is infertile, and most of the microslide preparations heavily stained green, *Halecium tubatum* can nevertheless be seen to differ widely from all other known species of *Halecium*. It somewhat resembles

Halecium tenellum Hincks, 1861 but that species is branched and the critical dimensions of the hydrotheca given by authors (Ritchie 1907, Cornelius 1995, Vervoort 1966, Millard 1975) are much smaller than those of *H. tubatum*.

Etymology. The species is named for the trumpet-like hydrotheca

Hydrodendron arboreum (Allman, 1888)

Figure 11A–C

Halecium robustum Allman, 1888: 10, pl. 4, figs 1-3.- Stranks, 1993: 7.

Halecium arboreum Allman, 1888: 89 (= *Halecium robustum*).

Hydrodendron arboreum - Rees and Vervoort, 1987: 20. - Vervoort, 1987: 88, fig. 10.2.- Peña Cantero, 1991: 50, pl. 2, figs a-f, pl. 63, fig. a.- Branch and Williams, 1993: 11, fig. - Peña Cantero and García Carrascosa, 1996: 13, figs 2A-F, 63E.- Peña Cantero and García Carrascosa, 1999: 212 *et seq.*

Hydrodendron arborea - Rees and Thursfield, 1965: 110.- Millard, 1977: 11, fig. 2E-G.

Ophiodissa arborea - Stechow, 1923a: 5.- Stechow, 1923b: 92.- Totton, 1930: 142, fig. 2a.- Briggs, 1939: 11.- Yamada, 1959: 35.- Vervoort, 1972: 25.- Blanco, 1994a: 156. - Blanco, 1994b: 188.

Ophiodes arboreus - Ritchie, 1913: 10, 15, figs 2-3.- Stechow, 1913a: 144. - Stechow, 1913b: 9, 87.- Billard, 1914: 8.- Jäderholm, 1919: 6, pl. 1, fig. 6. - Stepanjants, 1979: 110, pl. 21, fig. 1A-V. - Naumov, 1956: 464, 647.

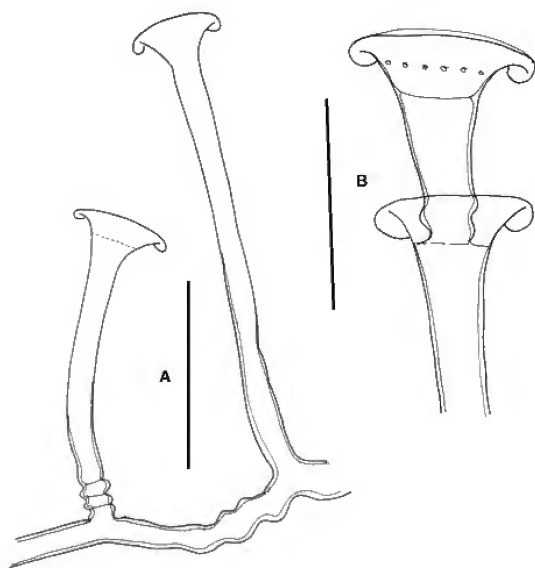


Figure 10. A, B. *Halecium tubatum*. A, hydrorhiza and two hydrothecae from holotype. B, hydrothecae enlarged. Scale bar: A, 0.5 mm. B, 0.3 mm.

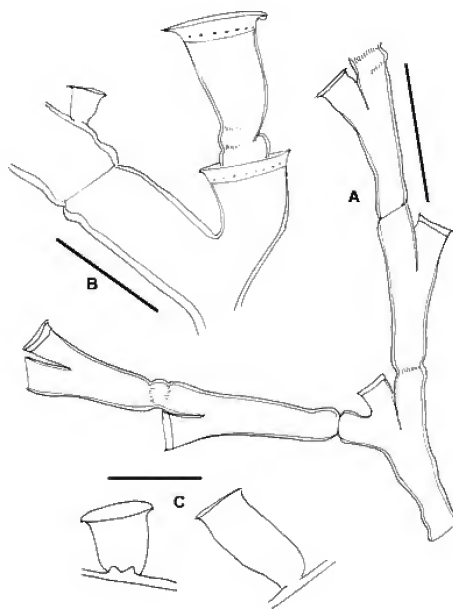


Figure 11. A – C. *Hydrodendron arboreum*. A, monosiphonic branch. B, hydrophores and nematotheca on branch. C, nematothecae. Scale bar: A, 1 mm. B, 0.5 mm. C, 0.3 mm.

Material examined. NMV F147474, Station 105, five microslides displaying branch fragments; some preserved infertile fragments. NMV F147475, Station 107, one microslide of two branch fragments; some preserved fragmental material.

Description. Hydorrhiza a tangle of thin, tubular, rugose stolons Stem (or branch) fragments 10 - 20 mm long, thick and woody, irregularly fascicled; ultimate branches monosiphonic; each new branch arising from side of a hydrophore; basal internode of some branches very long with several proximal constrictions, succeeding branch Internodes moderately long but variable, walls smooth, increasing slightly in diameter distally to hydrophore, nodes oblique to transverse, sloping away from hydrotheca, varying from a deep septum to a mere narrowing in perisarc, a tumescence above and often below node; longer internodes often with several weak proximal twists.

Hydrophores alternate, one on internode about two thirds distance up internode, length variable, hydrophore typically curving outwards at variable angles from internode, diameter about same internode; adnate to internode by a thick web of perisarc for three quarters of length then becoming free below hydrotheca; free part of hydrophore cylindrical, adcauline wall weakly convex, abcauline wall straight to weakly concave; hydrophores typically in linear series, each arising from diaphragm of preceding hydrotheca.

Hydrotheca shallow saucer-shaped, expanding from diaphragm to margin; margin circular, rim everted in a flange; diaphragm transverse, strong, a row of desmocytes above; occasional replications of margin.

Nematophores sparse, randomly scattered on internodes, small, goblet-shaped with outrolled rim.

Perisarc of branches thick, thinner and fragile on younger hydrophores and hydrotheca.

Colour (preserved material) of older stems honey brown, younger branches pale yellowish to colourless.

Measurements (µm)

Internode	
length	1,078 – 1,960
width at node	237 – 277
Hydrophore	
length of primary (adcauline wall to base of hydrotheca)	363 – 560
length of succeeding hydrophores	300 – 711
Hydrotheca	
depth, margin to diaphragm	79 – 81
diameter at margin	300 – 387
diameter of diaphragm	253 – 300
Nematophore	
length	195
Diameter of margin	137

Remarks. Many hydrothecae are damaged and reduced to a short collar just above the diaphragm. The few undamaged nematophores confirm the identity of the material as *Hydrodendron arboreum* Allman (1888). Allman (1888) and Totton (1930) describe large colonies to 25 cm high; the present fragmentary material may be branches of a similarly large colony.

Distribution. Exclusively Antarctic – Kerguelens, 192 m, McMurdo Sound 18 – 550 m, Gauss Station, Palmer Archipelago 92 m and Commonwealth Bay 100 – 545 m.

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References

- Allman, G. J. 1888. Report on the Hydroida dredged by H.M.S. *Challenger* during the years 1873-76. Part II. The Tubularinae, Corymorphinae, Campanularinae, Sertularinae and Thalamophora. *Report on the Scientific Results of the Voyage of HMS Challenger 1873-76, Zoology* 23:i-lxix, 1-90.
- Altuna, A., and García Carrascosa, A.M. 1990. *Euskal Herriko Medusa, Anemona eta Koralak*. Natur Zientzia, KRISELU, Donostia, Pp 1-116.
- Altuna Prados, A. 1995. Observaciones biogeográficas sobre los cnidarios bentónicos de la Costa Vasca. *Kobie* 22: 41-57.
- Altuna, A., Romero, A., Sanz, A., Torres-Gómez-de-Cadiz, J.A., and Ibañez, M. 1984. Contribución al conocimiento de la fauna marina de la costa Guipuzcoa I. *Lurralde, Investigación y espacio* 1983 (= 6): 127-155.
- Bale, W.M. 1888. On some new and rare Hydroida in the Australian Museum collection. *Proceedings of the Linnean Society of New South Wales* 3: 745-799.
- Bale, W.M. 1924. Report on some hydroids from the New Zealand coast, with notes on New Zealand Hydroida generally supplementing Farquhar's list. *Transactions of the New Zealand Institute* 55: 225-268.
- Billard, A. 1914. Hydroides. *Deuxième Expédition Antarctique Française (1908-1910), commandée par le Dr Jean Charcot* : 1-34.
- Blanco, O.M. 1984d. Adición a los hidrozooos Argentinos. II. *Revista del Museo de La Plata, new series* 13, *Zoologia* 147: 269-282.
- Blanco, O.M. and Bellusci de Miralles, D.A. 1972. Hydrozoos de la isla Pedro 1. *Contribuciones del Instituto antartico Argentino* 145: 1-29.
- Blanco, O.M. 1968. Nueva contribución al conocimiento de la fauna marina hidroide. *Revista del Museo de La Plata, new series* 10, *Zoologia* 87: 195-224.
- Blanco, O.M. 1984a. Contribución al conocimiento de hidrozooos antarticos y subantarticos. *Contribuciones del Instituto antartico Argentino* 294: 1-53.
- Blanco, O.M. 1984c. *Symplectoscyphus marionensis* Millard, 1971 (Hydroida, Thecata) y sus epizoicos. *Revista del Museo de La Plata, new series* 13, *Zoologia* 146: 261-267.
- Blanco, O.M. 1994a. Claves de familias y generos para facilitar el reconocimiento de los Hydroida (Leptolina) Athecata, Thecata y Limnomedusae Argentinos (generacion polipoide exclusivamente). *Revista del Museo de La Plata, new series* 14, *Zoologia* 160: 147-179.

- Blanco, O.M. 1994b. Enumeración sistemática y distribución geográfica preliminar de los Hydroida de la República Argentina suborden Athecata (Gymnoblastera, Anthomedusae), Thecata (Calypthoblastea, Leptomedusae) y Limnomedusae. *Revista del Museo de La Plata, new series* 14, *Zoología* 161:181-216.
- Bouillon, J., Massin, C., and Krešević, R. 1995. Hydroidomedusae de l'Institut Royal des Sciences naturelles de Belgique. *Documents de Travail de l'Institut Royal des Sciences Naturelles de Belgique* 78: 3-106.
- Branch, M.L., and Williams, G.C. 1993. The Hydrozoa, Octocorallia and Scleractinia of subantarctic Marion and Prince Edward Islands: illustrated keys to the species and results of the 1982-1989 University of Cape Town surveys. *South African Journal of Antarctic Research* 23:3-24.
- Briggs, E.A. 1938. Hydroida. *Scientific Reports of the Australasian Antarctic Expedition 1911-1914*, 9: 1-46.
- Broch, H. 1948. Antarctic Hydroids. *Scientific Results of the Norwegian Antarctic Expedition 1927-1928*, 28:1-23.
- Coughtrey, M. 1876a. Critical notes on the New Zealand Hydroida, suborder Thecaphora. *Annals and Magazine of Natural History* 17: 22-32.
- Coughtrey, M. 1876b. Critical notes on the New Zealand Hydroida. *Transactions and Proceedings of the New Zealand Institute* 8: 298-302.
- Day, J.B., Field, J.G., and Penrith, M.J. 1970. The benthic fauna and fishes of False Bay, South Africa. *Transactions of the Royal Society of South Africa* 39: 1-108.
- El Beshbeeshy, M. 1991. Systematische, Morphologische und Zoogeographische Untersuchungen an den Thekaten Hydroiden des Patagonischen Schelfs. Dissertation zur Erlangung des Doktorgrades des Fachbereichs Biologie der Universität Hamburg: 1-390.
- Genzano, G.N. 1996. La comunidad hidróide del intermareal de Mar del Plata (Argentina). I. Estacionalidad, abundancia y periodos reproductivos. *Cahiers de Biologie Marine* 35: 289-303.
- Genzano, G.N., and Zamponi, M.O. 1992. *Los hidrozooos bentónicos de la costa de mar del Plata*. Universidad Nacional de Mar del Plata, La Plata. 1-90.
- Gill, J.-M., Murillo, J., and Ros, J.D. 1989. The distribution pattern of benthic Cnidarians in the Western Mediterranean. *Scientia Marina* 53: 19-35.
- Gili, J.-M., Vervoort, W., and Pagés, F. 1989. Hydroids from the West African coast: Guinea, Bissau, Namibia and South Africa. *Scientia Marina* 53: 67-112.
- Gordon, D.P., and Ballantine, W. 1977. Cape Rodney to Okakari Point Marine Reserve. Review of knowledge and bibliography to December, 1976. *Tane* 22 (supplement): 1-146.
- Hirohito, Emperor of Japan. 1983. Hydroids from Izu Ōshima and Niihima. *Publications of the Biological Laboratory, Imperial Household, Tokyo* 1983: 1-83.
- Hirohito, Emperor of Japan. 1988. *The hydroids of Sagami Bay collected by His Majesty the Emperor of Japan*. Biological Laboratory of the Imperial Household, Tokyo 1988: 1-179.
- Hirohito, Emperor of Japan. 1995. The hydroids of Sagami Bay. II. *Publications of the Biological Laboratory, Imperial Household Tokyo* 1995: 1-355 (English text) 1-244 (Japanese text) edited and annotated, M. Yamada.
- Jäderholm, E. 1919. Zur Kenntnis der Hydroidenfauna Japans. *Arkiv för Zoologi* 12: 1-34.
- Leloup, E. 1960. Hydropolypes du Muséum National d'Histoire Naturelle de Paris. *Mémoires. Muséum National d'Histoire Naturelle, Nouvelle série (A)* 17(4): 217-241.
- Leloup, E. 1974. Hydropolypes calypthoblastiques du Chili. Report no. 48 of the Lund University Chile Expedition 1948-1949. *Sarsia* 55: 1-62.
- Medel, M.D., and Vervoort, W. 2000. Atlantic Haleciidae and Campanulariidae (Hydrozoa, Cnidaria) collected during the CANCAP and Mauritania-II expeditions of the National Museum of Natural History, Leiden, The Netherlands. *Zoologische Verhandelingen, Leiden* 330: 1-68.
- Millard, N.A.H. 1966a. The Hydrozoa of the south and west coasts of South Africa. Part III. The Gymnoblastera and small families of the Calypthoblastea. *Annals of the South African Museum* 48: 427-487.
- Millard, N.A.H. 1968. South African hydroids from Dr Th. Mortensen's Java-South Africa expedition, 1929-1930. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening i Kjöbenhavn* 131: 251-288.
- Millard, N.A.H. 1975. Monograph on the Hydroida of southern Africa. *Annals of the South African Museum* 68: 1-513.
- Millard, N.A.H. 1977a. The South African Museum's Meiring Naude cruises. Part 3. Hydroida. – *Annals of the South African Museum* 73: 105-131.
- Millard, N.A.H. 1977b. Hydroids from the Kerguelen and Crozet shelves, collected by the cruise MD.03 of the Marion-Dufresne. *Annals of the South African Museum* 73: 1-47.
- Morton, J., and Miller, M. 1973. *The New Zealand Sea Shore* 2nd edition. Collins, Auckland. 653 pp.
- Naumov, D.V., and Stepanjants, S.D. 1972. Hydroida. In *Marine Invertebrates from Adelie Land, collected by the XIIth and XVth French Antarctic Expeditions. 3. Téthys (supplement)* 4: 25-60.
- Naumov, D.V., and Stepanjants, S.D. 1962. Gidroidy podotryada Thecaphora, sobrannye v antarktičeskikh i subantarktičeskikh vodakh sovetskoi antarktičeskoi ekspeditsii na dizel'-elektrokhode Ob. In *Rezultaty Biologičeskikh Issledovanii Sovetskoi Antarktičeskoi Ekspeditsii (1955-1958 gg)*, 1. *Issledovaniya Fauny Morei* 1(9): 69-104. [In Russian] [English translation by Israel Program for Scientific Translations, Jerusalem, 1966, cat. no. 1500, as "Hydroida Thecophora collected by the Soviet Antarctic Expedition on the M/V Ob in Antarctic and Subantarctic waters". In: *Biological Results of the Soviet Antarctic Expedition (1955-1958). I. Studies of Marine Fauna*. 68-106.
- Naumov D.V., and Stepanjants, S.D. 1958. Gidroidy, obrannye v priantarktičeskikh vodakh. [Hydroids from the subantarctic waters]. *Informatsionnyi Byulleten' Svetskoi Antarktičeskoi Ekspeditsii 1955-1958*, 3: 57-58.
- Naumov, D.V. 1956. O nesoglasovannosti napravleniya i skorosti evolyutsionnogo protsessa u raznykh pokolenii metagenetičeskikh zhivotnykh. *Doklady Akademii Nauk SSSR* 108: 558-561.
- Park, J.-H. 1991. Systematic study on the marine hydroids (Cnidaria: Hydrozoa) in Korea. II. The families Sphaerocorynidae, Eudendriidae, Haleciidae and Lafoeidae. *Korean Journal of Zoology* 34: 541-547.
- Park, J.-H. 1992. Zoogeographical distribution of marine hydroids (Cnidaria: Hydrozoa: Hydroida) in Korea. *Korean Journal of Systematic Zoology* 8: 279-299.
- Park, J.-H. 1995. Hydroids (Cnidaria: Hydrozoa: Hydroida) from Chindo Island, Korea. *Korean Journal of Systematic Zoology* 11: 9-17.
- Patrity, G. 1970. Catalogue des cnidaires et cténaires des côtes Atlantiques Marocaines. *Travaux de l'Institut Scientifique Cherifien, Zoologie* 35: 1-149.
- Peña Cantero, A.L., and García Carrascosa A.M. 1996. Hidrozooos bentónicos de la campana Antártida 8611. *Instituto Español de Oceanografía. Publicaciones Especiales* 19: 1-147.
- Peña Cantero A.L., and García Carrascosa, A.M. 1999. Biogeographical distribution of the benthic thecate hydroids collected during the Spanish 'Antártida 8611' expedition and comparison between Antarctic and Magellan benthic hydroid faunas. *Scientia Marina* 63 (suppl. 1): 209-218.

- Pennycuik, P.R. 1959. Faunistic records from Queensland. Part V. Marine and brackish water hydroids. *Papers of the Department of Zoology, University of Queensland* 1: 141–210.
- Ralph, P.M. 1958. New Zealand thecate hydroids. Part II. Families Lafoeidae, Lineolariidae, Haleciidae and Syntheciidae. *Transactions of the Royal Society of New Zealand* 85: 301–356.
- Ralph, P.M. 1966. Hydroida. Port Phillip Survey 1957–1963. *Memoirs of the National Museum of Victoria* 27: 157–166.
- Ramil, F., and Vervoort, W. 1992. Report on the Hydroida collected by the "BALGIM" expedition in and around the Strait of Gibraltar. *Zoologische Verhandelingen, Leiden* 277: 3–262.
- Ramil, F., and Iglesias Diaz, A. 1988. La familia Haleciidae (Cnidaria, Hydrozoa) en las costas de Galicia. *Thalassas* 6: 71–78.
- Rees, W.J. and Thursfield, S. 1965. The hydroid collections of James Ritchie. *Proceedings of the Royal Society of Edinburgh* 69: 34–220.
- Rees, W.J., and Vervoort, W. 1987. Hydroids from the John Murray Expedition to the Indian Ocean, with revisory notes on *Hydrodendron*, *Abietinella*, *Cryptolaria* and *Zygophylax* (Cnidaria: Hydrozoa). *Zoologische Verhandelingen, Leiden* 237: 1–209.
- Rho, B.-J., and Park, J.-L. 1983. A systematic study on the marine hydroids in Korea. 7.
- Nine unrecorded species. *Journal of the Korean Research Institute for Better Living, Ewha Womans University* 31: 39–50.
- Ritchie, J. 1907a. The hydroids of the Scottish National Antarctic Expedition. *Transactions of the Royal Society of Edinburgh* 45: 519–545.
- Ritchie, J. 1913b. The hydroid zoophytes collected by the British Antarctic Expedition of Sir Ernest Shackleton, 1908. *Proceedings of the Royal Society of London* 33: 9–34.
- Roca, I., Moreno, I., and Barcelo, K. 1991. Distribución espacial y temporal de los Hidroideos de *Posidonia oceanica* (L). Delile en una pradera del illot del Sec (Bahia de Palma, Baleares). *Boletín del Instituto Español de Oceanografía* (1): 67–73.
- Smaldon, G., Heppell, D., and Watt, K.R. 1976. Type specimens of invertebrates (excluding Insects) held at the Royal Scottish Museum, Edinburgh. *Information Series. Royal Scottish Museum, Natural History* 4. i–iv, 1–118.
- Staples, D.A. and Watson, J.E. 1987. Associations between pycnogonids and hydroids. In J. Bouillon, F. Boero, F. Cicogna and P.F.S. Cornelius (eds), *Modern Trends in the Systematics, Ecology and Evolution of Hydroids and Hydromedusae*. Clarendon Press, Oxford: 215–226.
- Stechow, E. 1913a. Neue Genera thecater Hydroiden aus der Familie der Lafoeiden und neue Species von Thecaten aus Japan. *Zoologischer Anzeiger* 43: 137–144.
- Stechow, E., 1913b. Hydroidpolyphen der japanischen Ostküste. II. Teil: Campanulariidae, Haleciidae, Lafoeidae, Campanulinidae und Sertulariidae, nebst Ergänzungen zu den Athecata und Plumulariidae. In F. Doflein, Beiträge zur Naturgeschichte Ostasiens. *Abhandlungen der Mathematisch-Physikalischen Classe der Königlich Bayerischen Akademie der Wissenschaften (supplement)* 3: 1–162.
- Stechow, E. 1923a. Die Hydroidenfauna der japanischen Region. *Journal of the College of Science, Imperial University of Tokyo* 44: 1–23.
- Stechow, E. 1923b. Zur Kenntnis der Hydroidenfauna des Mittelmeeeres, Amerikas und anderer Gebiete. II. Teile. *Zoologische Jahrbücher, Abteilung für Systematik* 47: 29–270.
- Stepanjants, S.D. 1972. Gidroidy pribrezhnykh vod morya de,isa (po materialam XI sovetsko antarkticheskoy ekspeditsii 1965/66g. [Hydroidea of the coastal waters of the Davis Sea (collected by the XI Soviet Antarctic expedition of 1965–66)]. In Rezul'taty biologicheskikh issledovaniy Sovetskikh Antarkticheskikh Ekspeditsii. *Issledovaniya Fauny Morei* 11: 56–79.
- Stepanjants, S.D. 1979. Gidroidy vod antarktiki i subantarktiki. In Rezul'taty biologicheskikh issledovaniy Sovetskikh Antarkticheskikh Ekspeditsii, 6. *Issledovaniya Fauny Morei* 22: 1–99.
- Stranks, T.N. 1993. Catalogue of recent Cnidaria type specimens in the Museum of Victoria. *Occasional Papers of the Museum of Victoria* 6: 1–26.
- Totton, A.K. 1930. Coelenterata. Part V. Hydroida. *Natural History Report. British Antarctic Terra Nova Expedition 1910, Zoology* 5: 131–252.
- Vanhöffen, E. 1910: Die Hydroiden der Deutschen Siidpolar-Expedition 1901–1903. *Deutsche Siidpolar Expedition* 11 (= *Zoologie* 3): 269–340.
- Vervoort, W. 1972. Hydroids from the *Theta*, *Vema* and *Yelcho* cruises of the Lamont-Doherty Geological Observatory. *Zoologische Verhandelingen, Leiden* 120: 1–247.
- Vervoort, W. 1987. Evaluation of taxonomic characters in the Hydroida, particularly in the Thecata (= Leptomedusae). In J. Bouillon, F. Boero, F. Cicogna and P.F.S. Cornelius (eds), *Modern Trends in the Systematics, Ecology and Evolution of Hydroids and Hydromedusae*, Clarendon Press, Oxford: 83–103.
- Vervoort, W., and Watson, J.E. 2003. The Marine fauna of New Zealand: Leptothecata (Cnidaria: Hydrozoa) (Thecate Hydroids). *NIWA Biodiversity Memoir* 119: 1–537.
- Watson, J.E. 1973. Hydroids. Pearson Island Expedition 9. *Transactions of the Royal Society of South Australia* 97: 153–200.
- Watson, J.E. 1975. Hydroids of Bruny Island, southern Tasmania. *Transactions of the Royal Society of South Australia* 99: 157–176.
- Watson, J.E. 1979. Biota of a temperate shallow water reef. *Proceedings of the Linnean Society of New South Wales* 103: 227–235.
- Watson, J.E. 1994a. Shallow water hydroids from eastern Bass Strait. *Victorian Naturalist* 111: 65–69.
- Watson, J.E. 2003. Deep-water hydroids (Hydrozoa: Leptolida) from Macquarie Island. *Memoirs of Museum Victoria* 60: 151–180.
- Watson J.E., and Vervoort, W. 2001. The hydroid fauna of Tasmanian seamounts. *Zoologische Verhandelingen, Leiden* 334: 151–187.
- Yamada, M. (1959). Hydroid fauna of Japanese and its adjacent waters. *Publications from the Akkeshi Marine Biological Station* 9: 1–101.

***Lobataria newtoni* gen. et sp. nov., (Hydrozoa, Anthoathecata, Tubulariidae) from southern Australia**

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Abstract

Watson, J.E. 2008. *Lobataria newtoni* gen. et sp. nov., (Hydrozoa, Anthoathecata, Tubulariidae) from southern Australia. *Memoirs of Museum Victoria* 65: 179–184.

Lobataria newtoni gen. et sp. nov. differs from other members of the family Tubulariidae in possessing a hydrocaulus lacking internal canals, ridges or partitions. The hydroid is solitary, and attaches to old bivalve shells on sandy seabeds in sheltered shallow water habitats.

Keywords

Lobataria newtoni gen. et sp. nov., solitary tubularian hydroid, sheltered oceanic habitat, southern Australia.

Introduction

The hydroid described in this paper was found in shallow water by the author and colleagues at Blairgowrie and Rye on the eastern coast of Port Phillip, Victoria (southeastern coast of mainland Australia) in November 2007 and April, 2008. More specimens were observed in the same localities in July 2008 and also at Pt Richards on the western side of Port Phillip.

Six species of hydroids of the family Tubulariidae (Allman, 1864) have been recorded from temperate southern Australia: *Tubularia larynx* Ellis and Solander, 1786 [= *Ectopleura larynx* (Ellis and Solander, 1786)]; *Ectopleura crocea* (Agassiz, 1862), *Tubularia ralphii* Bale, 1884; *Zyzyzus spongiculus* (von Lendenfeld 1884); *Tubularia exxonia* Watson, 1978; *Ralpharia magnifica* Watson, 1980; *Ralpharia coccinea* Watson, 1984 and *Hybocodon cryptus* Watson, 1984.

Tubularia larynx was reported from Port Phillip by Ralph (1966) and Watson (1973) from Pearson Is.- in the Great Australian Bight. Re-examination of this material proved the species not to be *T. larynx* but a new hydroid, *Ralpharia magnifica* (Watson, 1980). While there is still some doubt about the relationship of *Tubularia ralphii* with *Ectopleura crocea*, it is likely that both are the same species (Watson 1999).

Distinction of genera in the family Tubulariidae is based upon the following characters:

- absence or presence and disposition of ectodermal ridges and canals in the hydrocaulus,
- whether the hydrocaulus widens or not distally above the base,
- the number of whorls of oral tentacles,

- presence or absence of branching of the blastostyle,
- reproduction by either medusa or actinula larva.

The order of importance accorded these characters varies among authors – Wedler and Larson (1986), Calder (1988), Petersen (1990), Migotto (1996), Bouillon (1999), Bouillon and Barnett (1999), Bouillon and Boero (2000), Schuchert (1996, 2001) and Bouillon et al. (2006).

The present material accords with the generally accepted concepts of these authors conforming most closely with the concept of *Tubularia* by Petersen (1990) and Bouillon et al. (2006). However, an important character of *Tubularia* defined by these authors is the presence of eight or more longitudinal canals in the hydrocaulus. In the present material the hydrocaulus is an open canal filled with parenchyme and lacks internal ridges or partitions thus setting it apart from the accepted concept of the Tubulariidae. A new genus, *Lobataria*, is therefore proposed.

Type material is lodged in Museum Victoria (NMVF).

***Lobataria* gen. nov.**

Diagnosis. Hydroid solitary, hydrorhiza a tubular stolon, hydrocaulus long, widening in diameter from base to distal end, inner lumen filled with parenchyme, without endodermal canals or longitudinal ridges, perisarc thin around neck, secreted from a groove between hydranth base and neck; hydranth vasiform with one whorl of filiform aboral tentacles continuing over hydranth base, and two whorls of filiform oral tentacles. Blastostyle unbranched, gonophores sessile cryptomedusoid with distal process and large lobate apical flanges; actinula larva released from gonophore.

Etymology. The genus is named for the conspicuous apical lobes of the gonophore.

***Lobataria newtoni* sp. nov.**

Material examined. Holotype: NMVF 157465, 1 fertile stem, alcohol preserved, Blairgowrie jetty, Port Phillip, Victoria, Australia, coll: J. E. Watson, 4 Nov 2007, depth 2 m; attached to old bivalve shell buried in sand. Paratype: NMVF 157466, 12 fertile stems, alcohol preserved, Blairgowrie jetty, Port Phillip, Victoria, Australia, coll: J. E. Watson, 4 Nov 2007, depth 2 m. Paratype, NMVF 157467, two fertile stems, alcohol preserved, Rye, Port Phillip, Victoria, Australia, coll: D. A. Staples, 23 Apr 2008, depth 2 m.

Description from holotype and paratype (live material). Hydroid solitary, hydrorhiza a simple undulating tubular stolon with thick perisarc, extending for a short distance from base of hydrocaulus over bivalve shell.

Hydrocaulus long and slender, narrow proximally, circular in section, increasing in diameter from base to hydranth, perisarc firm, closely and deeply corrugated proximally, corrugations continuing at irregular intervals for some distance above base, perisarc extending upwards into a filmy inflated collar below hydranth; hydrocaulus filled with parenchyme, no endodermal canals, ridges or partitions.

Hydranth moderately large, vasiform, aboral tentacles long, filiform, hollow, arranged in a single whorl of 28–34, base of tentacles oval; nematocysts abundant on proximal part of tentacles, becoming scattered distally along tentacle; about 24 short filiform oral tentacles arranged in a tight tuft of two rows.

Blastostyles arising just above aboral tentacles, moderately long, trailing between the tentacles, bearing 30–50 gonophores in clusters in various stages of development. Immature gonophore globular, tending to pyriform at maturity; just prior to maturity a long finger-like process protrudes from a central

apical orifice; at maturity apex surrounded by four radially arranged tall transparent lobate flanges which extend halfway down gonophores, edge of flange armed with a conspicuous row of large stenoteles (stenotele [i]).

Mature gonophore containing a single actinula pushing spadix to one side. Actinula at release with ten capitate aboral tentacles, directed alternately up and down and six filiform oral tentacles, aboral pole large, dome-shaped.

Measurements (mm) from holotype and paratypes

Hydrorhiza, width	0.2 – 0.4
Hydrocaulus	
Length	10 – 40
width at base	0.3 - 0.4
Hydranth	
diameter of basal collar	0.7 – 0.8
maximum length of aboral tentacles	9
maximum length of oral tentacles	2
width of aboral tentacle at base	0.4 – 0.5
Blastostyle, length	3 – 8
gonophore, length mature	0.5 – 1
peduncle of blastostyle, proximal width	0.3 - 0.5
Actinula	
overall length at release	0.9

Six kinds of nematocysts in three morphological categories present: stenoteles of four sizes and shapes, a desmoneme and a microbasic mastigophore each of one size.

Description, measurements (μm) and distribution of nematocysts

Nematocyst	Dimensions	Aboral tentacles	Oral tentacles	Gonophore and flange
Stenotele (i) capsule diameter shaft	10 – 14 10	A	R	A
Stenotele (ii) capsule (oval) shaft	11–15 x 8–10 9–10	N	C	A
Stenotele (iii) capsule (oval) shaft	8–10 x 6–7 8	A	A	A
Stenotele (iv) capsule (oval) shaft	8–10 x 6 8	A	A	Absent
Desmoneme capsule (bean-shaped)	6–7 x 5–6	A	A	Absent
Microbasic mastigophore capsule (elongate oval)	9–11 x 3–5	C	R	R

Key to abundance: A = abundant, C = common, N = not common, R = rare.

Colour. Hydrocaulus pale brown, hydranth flesh-pink, tentacles transparent white; developing female gonophores orange, changing to strawberry red at maturity; male gonophores paler, actinula white, spadix brown.

Etymology. The species is named for Andrew Newton, diving colleague and underwater photographer.

Remarks. *Lobataria newtoni* occurs on old bivalve shells buried at one to two centimetres in the sandy seabed on open sandy to silty seabed in shallow water with mild current flow. It is anchored to shells by a hydrorhiza comprising a short, sticky stolon coated with sand grains. The stolon often passes underneath the shell fragment to more securely anchor the hydrocaulus to the substrate. Most hydrocauli are solitary and widely scattered across the seabed although small patches of up to 10 hydranths rarely occur (fig. 1). This habit is similar to *Tubularia acadiae* (Petersen, 1990), which also attaches to old shell but the hydrocaulus of that species is canaliculate. Observations indicate *L. newtoni* occurs and is reproductive from summer to winter when water temperatures in Port Phillip range from 10°C (July) to 20°C (February).

Formation of the blastostyle commences early in the life of the hydranth. The developing gonophore contains many small eggs, but at maturity only one becomes an actinula. The large apical flanges surmounting the gonophore while rather variable in shape are typically lobate to ear-shaped. The peripheral band of large stenoteles bordering the flange is visible in living material even at low magnification. At release, most actinulae immediately settle on adjacent shell fragments and within a few hours develop a short hydrocaulus; exceptionally, juveniles sometimes attach to an adult stem, giving an appearance of a falsely branched hydrocaulus.

The lifespan of individual hydrocauli could not be ascertained as, despite searching one month after the first summer collection, all hydranths had disappeared from the original locality, only a few bare stems remaining. Recolonisation soon occurs, with new hydrocauli re-establishing in the same general microhabitat. Hydrocauli may have a very short life span or are rapidly lost due to fish or invertebrate grazing. An undescribed nudibranch of the genus *Cumanotus* (R. Burn, pers. comm.) was found feeding on unprotected tissue above the perisarc collar at the base of some hydranths.

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References

Agassiz, L. 1862. *Contributions to the Natural History of the United States of America*. Second monograph. Little, Brown & Co.: Boston. vol. 4: 1–viii, 380 pp.; plates 20–35.

- Allman, G. J. 1864. On the construction and limitation of genera among the Hydroida. *Annals and Magazine of Natural History* (3)13: 345–80.
- Bale, W. M. 1884. Catalogue of the Australian hydroid zoophytes. Australian Museum: Sydney. Pp. 1–198; plates 1–19.
- Bouillon, J. 1999. Hydromedusae. Pp. 385–465 in: Boltovskoy D. (ed.), *South Atlantic Zooplankton*. Vol. 1. Backhuys Publishers: Leiden.
- Bouillon, J. and Barnett, T.J. 1999. The Marine fauna of New Zealand: Hydromedusae (Cnidaria, Hydrozoa). *NIWA Biodiversity Memoir* 113: 1–136.
- Bouillon, J. and Boero, F. 2000. Phylogeny and classification of Hydroidomedusae. *Thalassia Salentina*, 24: 1–296.
- Bouillon, J., Gravili C., Pagès F., Gili J.-M. and Boero, F. 2006. An Introduction to Hydrozoa. *Mémoires du Muséum National d'Histoire Naturelle*, 194: 1–591.
- Calder, D.R. 1988. Shallow water hydroids of Bermuda. The Athecatae. *Royal Ontario Museum Life Science Contributions*, 148: 1–7.
- Ellis, J. and Solander, D.C. 1786. *The natural history of many common and curious zoophytes, collected from various parts of the globe By the late John Ellis, Esq. F.R.S. Soc. Reg. Upsal. Soc. author of the natural history of English corallines and other works. Systematically arranged and described By the late Daniel Solander, M.D.F.R.S. &c with sixty two plates engraved by principal artists*. Benjamin White & Peter Elmsly: London. i–xii, 206 pp.; plates 1–63.
- Migotto, A.E. 1996. Benthic shallow-water hydroids (Cnidaria, Hydrozoa) of the coast of São Sebastião, Brazil, including a checklist of Brazilian hydroids. *Zoologische Verhandelingen*, 306: 1–125.
- Petersen K. W. 1990. Evolution and taxonomy in capitate hydroids and medusae. *Zoological Journal of the Linnean Society*, 100: 10–231.
- Schuchert, P. 1996. Athecate hydroids and their medusae. *NIWA Biodiversity Memoir*, 106: 1–159.
- Schuchert P. 2001. Hydroids of Greenland and Iceland (Cnidaria, Hydrozoa) *Meddelelser om Grønland, Bioscience* 53: 1–184.
- von Lendenfeld, R. 1884. The Australian Hydromedusae. Part V. The Hydromedusinae, Hydrocorallinae and Trachomedusae. *Proceedings of the Linnean Society of New South Wales* (1884–85): 581–612.
- Watson, J.E. 1978. New species and new records of Australian athecate hydroids. *Proceedings of the Royal Society of Victoria*, 90: 301–14.
- Watson, J.E. 1980. The identity of two tubularian hydroids from Australia with a description and observations on the reproduction of *Ralpharia magnifica* gen. et sp. nov. *Memoirs of the National Museum of Victoria*, 41: 53–63.
- Watson, J.E. 1984. Two new species of tubularian hydroids from southern Australia. *Memoirs of the National Museum of Victoria*, 45: 7–12.
- Watson, J.E. 1999. Review of hydroids introduced to Victorian waters. Pp. 88–107 in: *Marine Biological Invasions of Port Phillip Bay*. Crimp Technical Report no. 20.
- Wedler E., and Larson, R. 1986. Athecate hydroids from Puerto Rico and the Virgin Islands. *Studies on Neotropical Fauna and Environment*, 21: 69–101.



Figure 1. Group of *Lobataria newtoni*, Blairgowrie, Port Phillip, Victoria, depth 2 m, July 2008.

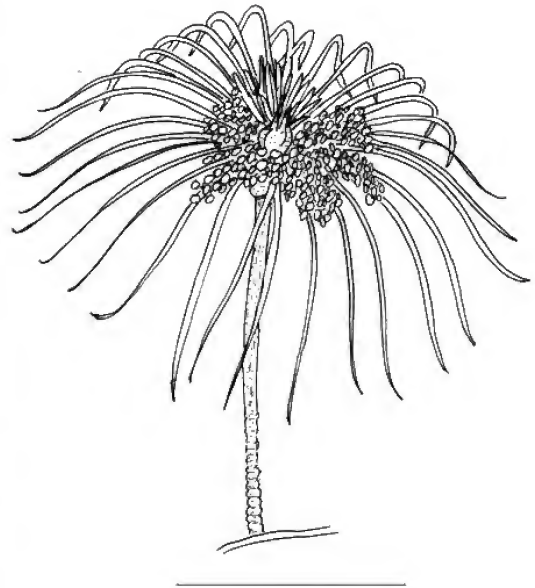


Figure 2. Fertile hydranth. Scale bar: 10 mm.

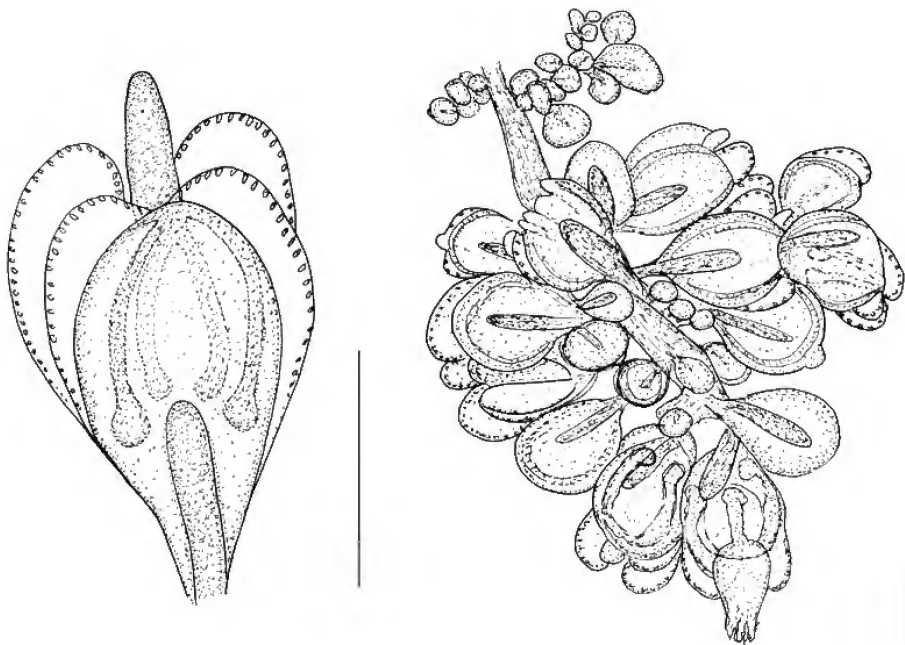


Figure 3. 3A: Blastostyle with gonophores in various stages of development. 3B: mature gonophore with lobate apical flanges, nematocysts and central protrusion. Scale bar: A, 1 mm; B, 0.5 mm.

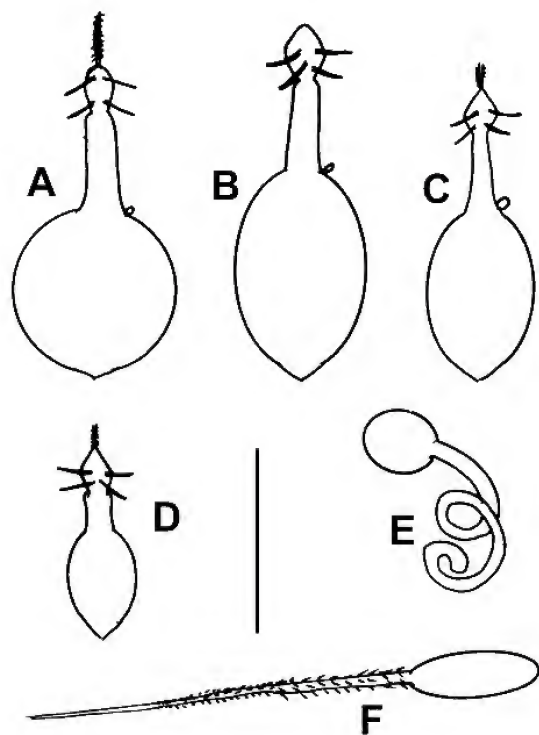


Figure 4. Nematocysts. 4A: stenotele (i) from gonophore flange. 4B: stenotele (ii) from oral tentacles. 4C: stenotele (iii) from aboral tentacles. 4D: stenotele (iv) from tentacles. 4E: desmonene from tentacles. 4F: microbasic mastigophore from aboral tentacles. Scale bar: 10 μ m.



***Corymorpha rubicincta*, a new Hydroid (Hydrozoa, Anthoathecata, Corymorphidae) from Port Phillip, Australia**

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Abstract

Watson, J.E. 2008. *Corymorpha rubicincta*, a new Hydroid (Hydrozoa, Anthoathecata, Corymorphidae) from Port Phillip, Australia. *Memoirs of Museum Victoria* 65: 185–188.

Corymorpha rubicincta sp. nov. a solitary hydroid is known only from shallow water silty seabed at the type locality in Port Phillip, Victoria, Australia. It is fertile in winter, gonophores are probably cryptomedusoid. The red hydrocauline band is diagnostic.

Keywords

Corymorpha rubicincta, Port Phillip, Australia, shallow water silty seabed, red hydrocauline band, cryptomedusoid.

Introduction

During an ecological survey in June, 2002, 1 km north-west of Point Richards in Port Phillip, Victoria, Australia, solitary hydroids were found in an abandoned dredge excavation 4–6 m deep. The habitat in the excavation is silty sand heavily bioturbated by infaunal polychaetes and bivalve molluscs. In June, 2008 more specimens were collected from the excavation and *in situ* underwater photographs taken. Water temperature at time of collection was 13°C.

Holotype and paratype material is lodged in Museum Victoria (NMVF).

Family Corymorphidae Allman, 1872

***Corymorpha* M. Sars, 1835**

Diagnosis (after Brinckman-Voss (1970), Petersen (1990) and Bouillon *et al* (2006).

Hydroid solitary, hydranth vasiform with one or several closely set whorls of oral filiform tentacles and aboral whorl of filiform tentacles; hydrocaulus with thin perisarc, with longitudinal peripheral canals; lower part with papillae and/or long anchoring filaments; parenchymatic diaphragm; gonophores borne on blastostyles just above aboral tentacles giving rise to free medusa or fixed sporosacs.

Material examined. Holotype NMVF147476, one stem alcohol preserved, coll: J.E. Watson, 5 June 2008. Paratypes, NMVF 147477, six stems alcohol preserved, coll: J.E. Watson, 18 June 2002. NMVF147478, six stems coll: J.E. Watson, 5 June 2008. All material

collected from 4.5–6 m depth. Material initially hardened in 5% formalin then transferred to alcohol.

Description (from live and preserved) holotype and paratypes Hydroids solitary, hydrocaulus up to 4 cm high, base of hydrocaulus blunt, embedded in sediment and rooted by a thick mass of soft, intergrown hair-like filaments adherent to sand grains; filaments slightly thicker near point of attachment to hydrocaulus.

Hydrocaulus cylindrical, widest at base, tapering gradually to a transverse red band about one third to half distance up stem; stem then of same diameter to base of hydranth. Perisarc above band thin and becoming almost colourless distally; a constriction at base of hydranth; in some stems a second red band at constriction marking junction of stem with hydranth. Cauline perisarc below primary band thick and gelatinous with numerous digitate pendulous papillae; papillae becoming shorter with distance up stem, gradually reducing to wavy discontinuous internal lines of cream-coloured spots sometimes interspersed with red blotches.

Hydranth long, vasiform, capable of great extension and contraction with a single whorl of 20–24 long, slender filiform aboral tentacles tapering to a pointed tip; approximately 30 oral tentacles, much shorter than aborals, arranged in a tuft of two closely set rows, tentacles in each row alternating with those above and below. Hypostome conical when closed and oral tentacles tightly bunched, when hypostome widely open, tentacles arched backwards.

Gonophores fixed sporosacs, borne on blastostyles set in one whorl just above aboral tentacles, a blastostyle usually between each second or third tentacle. Blastostyle short, stout, unbranched,

straight to backwardly recurved; up to 20 small subspherical to knuckle-shaped gonophores clustered in groups of three to five without peduncle along one side; gonophores probably cryptomedusoid with a thick epidermal layer heavily armed with nematocysts; more mature sporosacs packed with small ova.

Colour: rooting filaments colourless to greenish; lower two thirds of hydrocaulus yellow to reddish, colour gradually fading distally to primary band; primary band brick red; papillae below band cream. Body of hydranth pale flesh-colour, hypostome white to cream, usually a band of red spots just above aboral tentacles and similar spots on bases of inner row of oral tentacles; blastostyle and gonophores colourless to white. Tentacles translucent white.

Measurements (mm) of hydrocaulus from live specimens

Hydrocaulus	
length overall	20 – 40
diameter at base	2 – 3
diameter at cauline band	2.2 – 2.5
diameter below hydranth	1.5 – 2
distance from red cauline band to base of hydranth	5 – 12
Hydranth	
diameter at constriction below aboral tentacles	1.5 – 2
length of oral tentacle	3.8 – 4.5
length of aboral tentacle	12 – 14
Blastostyle (immature)	
length	0.1 – 1.5

Cnidome comprising one category (stenotele) of five size classes and three categories of nematocysts each of one size class (desmoneme, microbasic mastigophore, heterotrichous anisorhiza).



Figure 1. *Corymorpha rubicincta*, fertile hydranth, *in situ* image, depth 5 m.

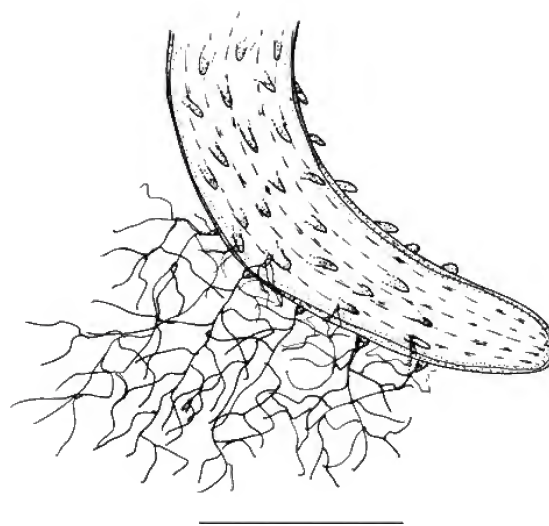


Figure 2. Rooting filaments, drawn from paratype. Scale bar 5 mm.

Nematocysts, measurements (μm)

Nematocyst	Dimensions	Aboral Tentacle	Oral Tentacle	Gonophore
Stenotele (i)		Absent	N	A
capsule	18-19 x 13-15			
shaft	13			
Stenotele (ii)		Absent	Absent	A
capsule	15-17 x 14-15			
shaft	14			
Stenotele (iii)		C	Absent	Absent
capsule	14-16 x 11-14			
shaft	12			
Stenotele (iv)		A	Absent	R
capsule	12-13 x 8-10			
shaft	8-10			
Stenotele (v)		Absent	C	Absent
capsule	10-11 x 8-9			
shaft	8			
Desmoneme	7-10 x 6-8	A	A	Absent
Microbasic mastigophore	12-15 x 4-6	A	A	C
Heterotrichous anisorhiza		R	Absent	R
diameter	15-16			

Key to abundance: A = abundant, C = common, N = not common, R = rare

Aboral, oral tentacles and gonophores with abundant stenoteles. Desmonemes absent from gonophores. The heterotrichous anisohoriza has a very long and spinous thread.

Remarks

Similar species of *Corymorpha* considered were: *Corymorpha nutans* M. Sars, 1835, *Corymorpha januarii* Steenstrup, 1854 and *Corymorpha forbesii* (Mayer, 1894); all were rejected because they have many more aboral tentacles than *Corymorpha rubicincta* and moreover, all release medusae. Other Pacific records of *Corymorpha* are *Corymorpha symmetrica* Hargitt, 1924 and *Corymorpha tomoensis* Ikeda, 1910, and *Corymorpha sagamina* Hirohito, 1988 both of which are also likely to produce medusae. *Corymorpha carnea* (Clark, 1876) is about three times larger, has branched blastostyles and medusoid gonophores (see Hirohito, 1988).

The only previous record of *Corymorpha* from Australia is that of Stechow (1932) who described *Corymorpha* (*Euphysa*) *balsii* from Shark Bay in Western Australia. His infertile colony was from the carapace of the spider crab *Schizophrys dama*, the type material of which is lodged in the Zoologische Staatssammlung, München (Ruthensteiner *et al.* 2008). The carapace of a crab (see photograph, Figure 2E, Ruthensteiner *et al.*, 2008) seems an unlikely habitat for *Corymorpha* which is usually found on a silty seabed. Ruthensteiner *et al.* (2008) also give a figure (Figure 7B) of a previously unpublished illustration of a specimen of *Corymorpha* drawn by Stechow's graphicist W. Rössler which may be Stechow's specimen of *C. balsii*. Examination of the colony on the crab carapace will settle the question of whether it is indeed a *Corymorpha* or more likely, a species of *Zyzzyus*. Although I have not examined this material and while the true identity of Stechow's material needs to be established, the species is clearly not *Corymorpha rubicincta*.

The lines passing upwards through the hydrocaulus of *Corymorpha rubicincta* are obscured in the lower stem region by the thick gelatinous perisarc. Under high magnification the reddish specks and blotches throughout the hydrocaulus

appear to be groups of zooxanthellae. Papillae are present on the lower part of most stems but are absent from some stems and may develop as the hydrocaulus matures; well developed papillae are long and finger-like, becoming button-like up the stem, then gradually fading to blotches in the perisarc. The distinctive red band part way up the stem is present in all hydrocauli; only some stems have the secondary, thinner band below the hydranth.

Blastostyles were abundant on specimens collected in June (winter) of 2002 and 2008 but were absent from the few hydrocauli remaining at the locality six weeks later in July, 2008. The thick epidermal layer of the gonophores obscures the internal structures thus preventing accurate diagnosis

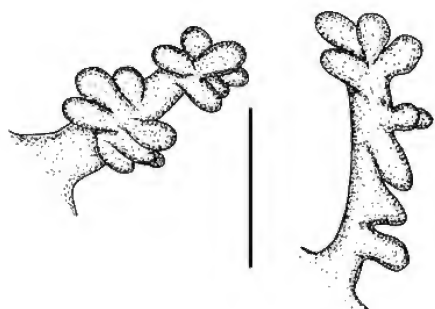


Figure 3 Blastostyle, two views showing developing gonophores. Scale bar, 1 mm.

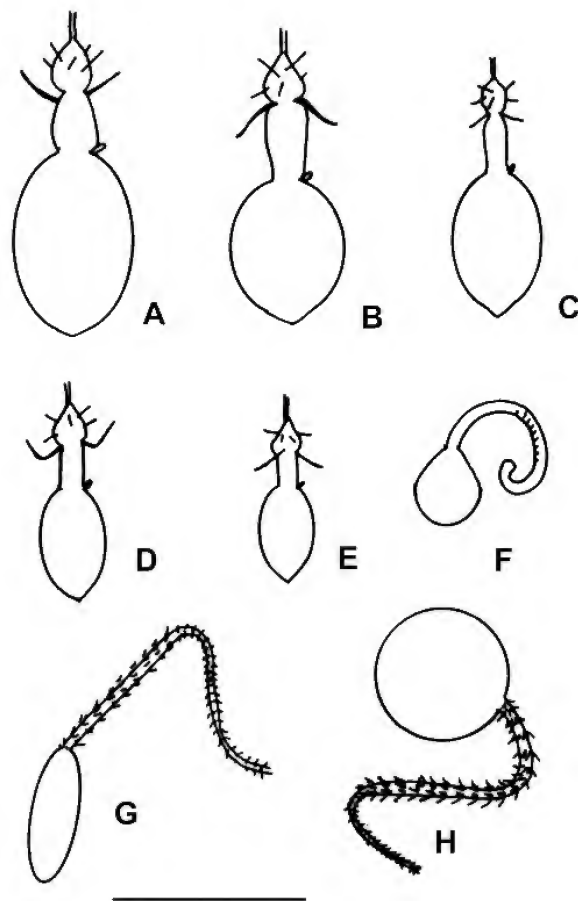


Figure 4. Cnidome. 4A, stenotele (i) from oral tentacles. 4B, stenotele (ii) from gonophores. 4C, stenotele (iii) aboral tentacles. 4D, stenotele (iv) from aboral tentacles and gonophores. 4E, stenotele (v) from oral tentacles. 4F, desmoneme from oral and aboral tentacles. 4G, microbasic mastigophore. 4H, heterotrichous anisohoriza from aboral tentacles and gonophore. Scale bar, 20 μ m.

however, they are almost certainly cryptomedusoid. The ova are small, 10-32 μm in diameter, although not numerous and are visible only under high magnification when the gonophore is crushed. An *in situ* image (June 2008) showed a group of 35 young hydrocauli (some to 6 mm high) grouped around the base of a parent stem, suggesting that fertilized ova may drop from the gonophore directly to the substrate to commence growth as new hydrocauli.

Information on the cnidome of the hydroid of *Corymorpha* is from Bouillon (1985), Schuchert (1996) and da Silveira and Migotto (1992) who list desmonemes, anisorhizas, stenoteles and micro- and macrobasic mastigophores and heterotrichous anisorhizas. With the exception of macrobasic mastigophores *Corymorpha rubicincta* has the same categories of nematocysts.

This is the first undoubted record of *Corymorpha* from Australia.

Ecology. *Corymorpha rubicincta* occurs on silty substrate in quiet water conditions within a narrow depth range of 5–6 m on the sloping sides of an old excavation in the seabed. The rather flaccid scattered hydrocauli stand more or less erect above the bed. It may be a summer species as intensive search at the type locality in July (mid-winter) at a water temperature of 10°C found only two moribund stems.

Etymology. The species is named for the red band encircling the hydrocaulus.

Acknowledgements

I thank Andrew Newton for underwater photography of the hydroids and Dr Wim Vervoort of the National Museum of Natural History, Leiden, The Netherlands, for helpful advice and Dr Peter Schuchert of Muséum d'Histoire Naturelle, Genève, Switzerland for criticism of the manuscript.

References

Allman, G.J. 1872. *A Monograph of the Gymnoblasic or tubularian hydroids* I-II. Ray Society, London 450 p.

- Da Silveira F. and Migotto A. 1992. Rediscovery of *Corymorpha januarii* Steenstrup, 1864 (Hydrozoa, Corymorphidae) on the southeastern coasts of Brazil. *Steenstrupia* 18(4):81-89.
- Sars, M. 1835. *Beskrivelser og jagttagelser over nogle maerkelige eller nye i havet ved den Bergenske kyst levende dyr af polypernes, acelppheres, radiaternes, annelidermes og molluskernes classer, med en kort oversigt over di hidtil af forfatteren sammesteds fundne arter og deres forekommen*. T. Hallager, Bergen, xii, 81 p.
- Bouillon J. 1985a. Essai de classification des Hydropolypes-Hydroméduses (Hydrozoa-Cnidaria). *Indo-Malayan Zoology* 2: 29-243.
- Bouillon J., Gravili, C., Pagès, F., Gili J.-M. and F. Boero. 2006. An Introduction to Hydrozoa *Mémoires du Muséum national d'Histoire naturelle* 194:1-591.
- Brinckman-Voss A. 1970. Anthomedusae/Athecata (Hydrozoa, Cnidaria) of the Mediterranean. Part 1. Capitata – Fauna e Flora Golfi di Napoli 39:1-96, pls 1-11.
- Hirohito, Emperor of Japan 1988. The hydroids of Sagami Bay collected by His Majesty the Emperor of Japan. Biological Laboratory of the Imperial Household, Tokyo. pp. 1-179, pls 1-4.
- Petersen W. 1990. Evolution and taxonomy in capitate hydroids and medusa. *Zoological Journal of the Linnean Society* 100(2): 101-231.
- Ruthensteiner B., Reinicke, G.-B. and Straube, N. 2008. The type material of Hydrozoa described by Eberhard Stechow in the Zoologische Staatssammlung, München. *Spixiana* 31(1): 3-27.
- Schuchert P. 1996. The Marine Fauna of New Zealand: athecate hydroids and their medusae (Cnidaria: Hydrozoa). New Zealand Oceanographic Institute (NIWA) Memoir 106: 1-159.
- Schuchert P. 2001. Hydroids of Greenland and Iceland (Cnidaria, Hydrozoa). *Meddelelser om Grønland. Bioscience* 53: 1-184.
- Stechow E. 1932. Neue Hydroiden aus dem Mittelmeer und einige Pazifischen Ozean, nebst Bemerkungen über einige wenig bekannte Formen. *Zoologischer Anzeiger* 100: 81-92.
- Steenstrup J. J. S. 1854. En ny og tropisk Art af Smaagoplernes Ammeslaegt: *Corymorpha* Sars (*Corym. Januarii* Stp.). *Videnskabelige Meddelelser fra dansk naturhistorisk Forening* (1-3): 46-48.

A New Species of the Roughy Genus *Hoplostethus* (Trachichthyidae) off North-western Australia.

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Abstract

Gomon, M.F. 2008. A New Species of the Roughy Genus *Hoplostethus* (Trachichthyidae) off North-western Australia. *Memoirs of Museum Victoria* 65: 189–194.

Hoplostethus ravurictus n.sp. is described from a large series collected at continental slope depths in tropical latitudes off North-western Australia. Its description brings the number of documented Australian species of the subgenus *Hoplostethus* (*Hoplostethus*) to four, the three previously recognised species primarily occurring in subtropical and temperate waters of the south. The new species is easily distinguished by the rather pale pigmentation in its buccal and branchial cavities, 13–16 (rarely 10–12 or 17–20) abdominal scutes and fully scaled isthmus. Its characters do not support a particularly close relationship with any of its recognised congeners.

Keywords

Roughy, *Hoplostethus*, Trachichthyidae, new species, Australia.

Introduction

In the most recent overview of the trachichthyid genus *Hoplostethus* Cuvier (in Cuvier and Valenciennes, 1829), Kotlyar (1996) recognised four subgenera, three with rather delicate cranial structures and the fourth, *Hoplostethus* (*Hoplostethus*), having a more substantial ossification of the skull, and a shallower bathymetric distribution overall relative to the others. In that study the vast majority of species in the genus are placed in *H. (Hoplostethus)* with 13 species, and *H. (Leiogaster)* with six. The latter increased to seven with the subsequent description of *H. vniro* Kotlyar, 1995. The status of the subgeneric assemblages remains untested.

Kotlyar recorded two species of *H. (Hoplostethus)* in Australian waters, *H. mediterraneus* (Cuvier, 1829) and *H. gigas* (McCulloch, 1914), neither presented as occurring above the southwestern corner of Western Australia on the west coast. Gomon (in Gomon et al., 1994) reported three species that are referable to the subgenus in southern Australian waters, *H. intermedius* (Hector, 1875; regarded by Kotlyar as a subspecies of *H. mediterraneus*), *H. gigas* and *H. latus* McCulloch, 1914, the last distributed northwards at least to Geraldton on the west coast. Kotlyar (1996) had placed *H. mediterraneus* var *latus* in synonymy with *H. mediterraneus*, but a number of characters readily separate the two at the species level (Gomon, in Gomon et al., 1994). The distributions of the two species overlap only between the southwest corner

of Australia and the middle of the Great Australian Bight.

Since the early 1980s, trawlers working the upper slope off North-western Australia have collected specimens of an additional species with characteristics that do not match any in the literature. A description of that species follows.

Methods and Materials. Terminology and methodology is that of Kotlyar (1996). The number and size range in standard length (SL) for each lot of specimens examined is presented as a parenthetical expression after the respective registration number. Institutional abbreviations are listed in Leviton et al., (1985). Paratypes measured to determine morphometric variability are marked with an asterisk in the list of paratypes below. Numbers enclosed by square brackets in the species description indicate the number of specimens or structures counted with that value. Scale terminology is that of Roberts (1993).

Hoplostethus ravurictus n. sp.

Figures 1–2; Tables 1–2

Hoplostethus sp. Gloerfelt-Tarp and Kailola, 1984: 315, voucher WAM P.26209-015.

Hoplostethus sp. Sainsbury et al., 1984: 334, CAAB 37255006, voucher CSIRO CA308.

Materials examined. Holotype: NMV A29668-002 (123) Western Australia, Hedland, 18°34.28'–18°34.20'S, 117°27.40'–117°28.17'E, 407–404 m, RV *Southern Surveyor* SS05/2007/049, 14 Jun 2007.

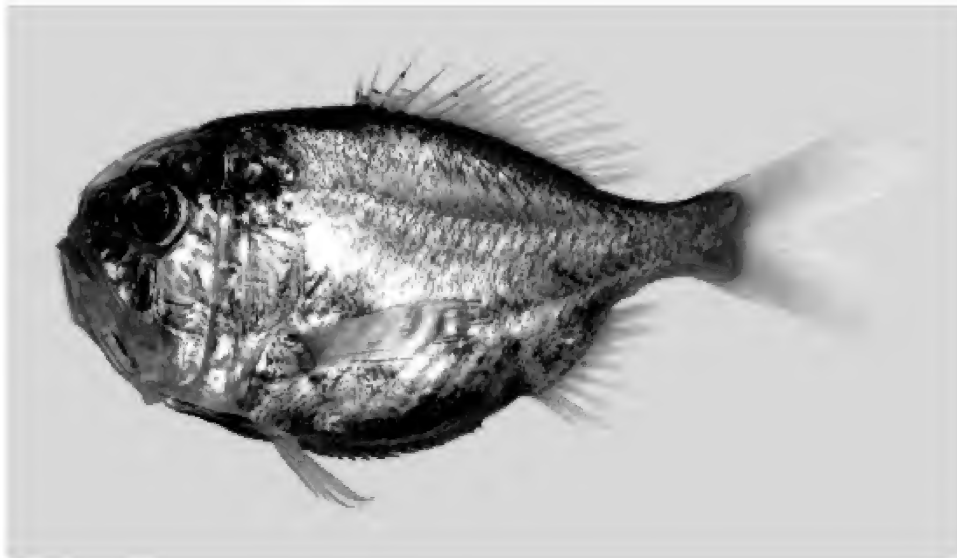


Figure 1. *Hoplostethus ravurictus* n. sp., holotype NMV A29668-002, 123 mm SL, Western Australia, Hedland, 407–404 m.

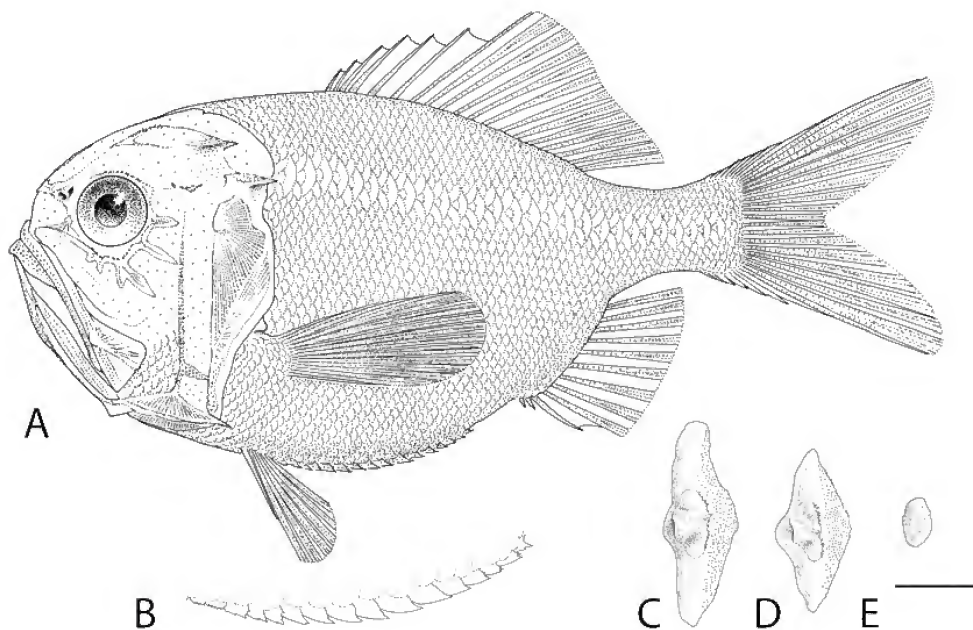


Figure 2. *Hoplostethus ravurictus* n. sp.: (A) holotype, NMV A29668-002, 123 mm SL; (B) abdominal scutes; (C) anterior lateral line scale; (D) posterior lateral line scale; and, (E) scale from just below dorsal fin base. Scales from NTM S12734-005, paratype, 141 mm SL. Bar associated with scales equals 5 mm.

Table 1. Frequency of meristic values in type specimens. Values for holotype are marked with an asterisk.

	Dorsal Fin							Anal Fin Rays		
	Spines			Rays		Total				
No. of elements	V	VI	VII	13	14	19	20	8	9	10
No. of specimens	2	77*	1	76*	4	77*	3	1	77*	2

	Caudal Fin Rays										
	Dorsal						Ventral				
	Unsegmented		Segmented				Segmented			Unsegmented	
			Unbran.	Branched			Branched		Unbranched		
No. of elements	6	7	2	8	9		8	9	1	2	
No. of specimens	56	23*	79*	3	76*		79*	1	1	78*	

	Pectoral Fin Rays				Vertebrae			
	13	14	15	16	11+14	12+14	11+15	11+16
No. of specimens	1	5	121*	3	2	1	70*	1

	Outer Gill Rakers on 1st Gill Arch										
	Upper Limb			Angle	Lower Limb			Total			
	5	6	7	1	11	12	13	18	19	20	21
No. of specimens	1	64*	3	78*	3	42*	23	4	41*	20	3

	Abdominal Scutes										
	10	11	12	13	14	15	16	17	18	19	20
No. of specimens	1	1	1	16	19	19*	10	2	4	0	1

Paratype: (78, 25.4–141 mm SL). AMS I.23425-004 (5, 84.4–103) Western Australia, northwest shelf, 18°46'S, 117°00'E, 400 m, RV *Soela*, 1 Sep 1982; CAS 227136 (3, 78.7–116), same collection data as NTM S12734-005 below; CSIRO CA308 (95.0) Western Australia, SW of Rowley Shoals, 18°19'–18°18'S, 118°17'–118°08'E, 297–308 m, FRV *Courageous*, 20 May 1978; CSIRO CA3588 (64.8) Western Australia, SW of Imperieuse Reef, Rowley Shoals, 18°03.5'–17°56.7'S, 118°13.0'–118°21.2'E, 418–420 m, FRV *Soela*, SO0183/69, 5 Feb 1983; CSIRO CA3597 (122) Western Australia, SW of Imperieuse Reef, Rowley Shoals, 18°03.5'–17°56.7'S, 118°13.0'–118°21.2'E, 418–420 m, FRV *Soela*, SO0183/69, 5 Feb 1983; CSIRO CA3598 (112) Western Australia, SW of Imperieuse Reef, Rowley Shoals, 18°03.5'–17°56.7'S, 118°13.0'–118°21.2'E, 418–420 m, 'FRV *Soela*', SO0183/69, 5 February 1983; CSIRO CA3809 (91.8) Western Australia, SW of Imperieuse Reef, Rowley Shoals, 18°11.0'–18°07.0'S, 118°04.0'–118°09.0'E, 400–404 m, FRV *Soela*, SO0183/68, 5 Feb 1983; CSIRO H2106-1 (78.0) Western Australia, NE of Mermaid Reef, Rowley Shoals, 16°54'S, 120°25'E, 393 m, *Striker*, SO0588/70, 27 Sep 1988; CSIRO H2898-10 (3, 74.2–99.2) Western Australia, SW of Rowley Shoals, 18°03.8'–18°07.1'S, 118°16.3'–118°12.3'E, 357–361 m,

FRV *Southern Surveyor*, SS0491/112, 26 Sep 1991; CSIRO H2899-03 (114) Western Australia, SW of Rowley Shoals, 18°04.6'–17°59.3'S, 118°13.6'–118°19.5'E, 379–394 m, FRV *Southern Surveyor*, SS0491/113, 27 Sep 1991; CSIRO H4031-04 (68.9) Western Australia, N of Cape Lambert, 18°58.2'–18°57.6'S, 117°12.1'–117°14.6'E, 253–248 m, FRV *Southern Surveyor*, SS0895/59, 30 August 1995; CSIRO H4031-05 (5, 50.5–58.5) Western Australia, N of Cape Lambert, 18°58.2'–18°57.6'S, 117°12.1'–117°14.6'E, 253–248 m, FRV *Southern Surveyor*, SS0895/59, 30 Aug 1995; CSIRO H4664-02 (47.9) Western Australia, Rowley Shoals area, 17°38.9'–17°37.0'S, 119°00.3'–119°00.8'E, 310 m, FRV *Southern Surveyor*, SS0797/123, 31 Aug 1997; NMNZ P.44687 (125), NMNZ P.44689 (108), same collection data as NTM S12734-005 below; NMV A29662-005* (76.3) Western Australia, Dampier, 19°43.78'–19°43.57'S, 115°21.22'–115°20.60'E, 389–423 m, RV *Southern Surveyor*, SS05/2007/034, 12 Jun 2007; NMV A29668-022* (92.9), same collection data as holotype; NMV A29670-009* (86.3) Western Australia, Leveque, 14°36.52'–14°35.77'S, 121°19.77'–121°21.20'E, 712–709 m, RV *Southern Surveyor*, SS05/2007/103, 26 Jun 2007; NMV A29703-014 (82.7) Western Australia, Leveque,

Table 2. Standard lengths and selected morphometric values expressed as percent SL for the holotype and 17 paratypes of *Hoplostethus ravurictus* n. sp.

<i>Hoplostethus ravurictus</i> n.sp.		
	holotype	paratypes (n=17)
Standard length (mm)	92.9	75.0-141.0
Body depth	52.5	49.2-55.0
Head length	40.3	38.2-42.2
Head height	46.2	43.5-47.6
Forehead height	5.4	3.3-6.4
Eye diameter	11.0	10.1-14.0
Postorbital length	19.2	15.2-20.9
Interorbital width	12.0	11.2-13.3
Maxillary length	28.3	26.9-30.2
Lower jaw length	29.9	27.6-30.7
Snout length	8.1	5.6-10.4
Caudal peduncle depth	12.6	11.2-13.3
Caudal peduncle length	20.6	19.4-23.6
Predorsal length	49.4	47.3-52.1
Preanal length	69.1	67.4-76.8
Prepectoral length	39.4	35.6-42.3
Prepelvic length	44.4	41.7-46.9
Pectoral Pelvic length	9.7	8.8-13.1
Pelvic Anal length	32.8	28.0-38.5
Dorsal base length	38.1	35.7-41.6
Anal base length	19.7	15.4-19.8
Pectoral fin length	31.3	28.0-32.2
Pelvic fin length	24.8	20.8-25.4
1st dorsal spine length	3.1	0.4-4.0
2nd dorsal spine length	6.7	4.3-8.4
Last dorsal spine length	14.6	12.5-18.9
1st anal spine length	1.3	0.8-1.6
Last anal spine length	10.4	7.2-12.5

14°53.48'–14°53.27'S, 121°33.92'–121°36.10'E, 285–302 m, RV *Southern Surveyor*, SS05/2007/108, 27 Jun 2007; NMV A29703-015* (75.0), as for NMV A29703-014; NMV A29703-016 (2, 72.5–78.3), as for NMV A29703-014; NTM S12288-026 (5, 69.5–83.0), Northern Territory, Arafura Sea, E of Evans Shoal, 09°46'S, 130°14'E, 270–300 m, 15 Sep 1987, NT Fisheries; NTM S12456-001* (85.0), Northern Territory, Arafura Sea, N of Bathurst I, 09°46'S, 130°00'E, 275 m, 7 Jul 1988, M. Sachse; NTM S12604-002 (4, 79.2–89.0), Western Australia, NW shelf, off Rowley Shoals, 17°39'S, 118°41'E, 405 m, 5 Nov 1985, W. Houston; NTM S12605-001 (99.5), Western Australia, NW shelf, off Rowley Shoals, 17°52'S, 118°27'E, 420 m, 6 Nov 1985, W. Houston; NTM S12606-012 (6, 73.2–94.9), Western Australia, NW shelf, off Rowley Shoals, 18°00'S, 118°16'E, 430 m, 6 Nov 1985, W. Houston; NTM S12610-009* (2, 75.2–130), Western Australia, NW shelf, off Rowley Shoals, 17°52'S, 118°28'E, 415 m, 7 Nov 1985, W. Houston; NTM S12641-004 (59.0), Western Australia, NW shelf,

NW of Lynher Bank, 14°50'S, 121°35'E, 275–280 m, 15 Jul 1989, J. Baille; NTM S12694-004 (2, 68.0–87.5), Western Australia, NW shelf, off Rowley Shoals, 17°28'S, 118°53'E, 400 m, 4 Nov 1985, W. Houston; NTM S12727-009 (113), Western Australia, SW of Rowley Shoals, 17°52'S, 118°28'E, 410 m, 9 Feb 1990, D. Evans; NTM S12728-005 (3, 75.0–86.1), Western Australia, SW of Rowley Shoals, 18°01'S, 118°23'E, 420 m, 6 Feb 1990, D. Evans; NTM S12734-005* (4, 75.3–141), Western Australia, Exmouth Plateau, 19°49'S, 113°34'E, 1020 m, 23 Feb 1990, D. Richardson; NTM S13138-004 (2, 73.0–78.5), Northern Territory, Arafura Sea, E of Evans Shoal, 09°48'S, 130°07'E, 265 m, 14 Dec 1990, D. Evans; QM I.38272* (3, 80.5–114), same collection data as NTM S12734-005 above; USNM 393569* (3, 78.5–121), same collection data as NTM S12734-005 above; WAM P.25401.017 (25.4), Western Australia, Rowley Shoals, Browse I, 13°47'S, 123°18'E, 242 m, 23 Dec 1969; WAM P.26209.015 (4, 43.2–70.1) Western Australia, 18°18'S, 118°08'E, 297–330 m, FV

Courageous, J.B. Hutchins, 20 May 1978; WAM P.30576.018 (105), Western Australia, SW of Rowley Shoals, 17°59'S, 118°18'E, 420–416 m, RV *Soela*, 27 Jan 1984, CSIRO.

Other material. QM I.33908 (2, 67.3–68.9), Western Australia, NNE of Dampier, 18.58°S, 117.12°E, 248–253 m; WAM P.21599.001 (2, 93.9–105), Western Australia, Rowley Shoals, 13°45'S, 123°31'E, 250 m, 23 Dec 1969.

Diagnosis. Pectoral fin rays 15, rarely 13, 14 or 16; abdominal scutes 13–16, rarely 10–12 and 17–20, some scutes in large individuals with multiple apical points; isthmus covered with small spinoid scales; body rectangular, depth distinctly shorter than length, 1.9–2.0 in SL; nape almost straight, forehead turning abruptly downward above upper lip; body silvery in life, buccal cavity and opercular recess pale to slightly dusky.

Description. (See Table 1 for frequencies of values for selected meristic characters.) Dorsal fin rays VI, 13 (V–VII, 13 or 14 = 19 or 20); anal fin rays III 9 (III, 8–10); caudal fin rays 7 + 2 + 9 + 8 + 2 + 6 (6 or 7 + 2 + 8 or 9 + 8 or 9 + 1 or 2 + 5–7); pectoral fin rays 15 (13–16); pelvic fin rays I, 6; gill rakers 6 + 1 + 12 (5–7 + 1 + 11–13 = 18–21); lateral line scales 27 (26–28); transverse scales 12/1/22 (9–12/1/20–24); predorsal scales 20 (17–22); scutes 15 (10–20); vertebrae 11 + 15 (11–12 + 14–16 = 25–27); pyloric caeca about 15 (based on NTM S12734-005); pseudobranch 19 (16–21); branchiostegal rays 8.

(See Table 2 for comparative ranges of selected morphometric characters.) Body ovoid, distinctly longer than deep, depth 1.86–2.03 in SL. Head large, its height slightly greater than its length, 107–116% HL; upper profile in front of dorsal fin gently curved to back of head, with mostly straight forehead, and an abrupt downturn above upper lip; forehead deep, anterodorsal profile separated from above orbital rim by distance 8.4–15.7% HL; space between eyes bulging and wide, interorbital width 27.6–32.8% HL; eye of moderate size, 25.9–33.1% HL; crests of head bones strong, fine spinules on apices at skin surface; depressions between crests moderately deep; mouth reaching to below hind margin of eye (to slightly beyond in juveniles); fine denticulate teeth covering oral margins of premaxilla and dentary, extending onto lateral surfaces, palatine with narrow band of similar teeth, vomer without teeth (with or without one to several small teeth). Preopercular spine long, not quite reaching ventral-fin base. Humeral spine smaller than preopercular spine. Longest gill raker about 2/3 eye diameter; gill filaments at angle of first gill arch very short, about 1/10 eye diameter and about 1/3 length of longest filaments of pseudobranch. Body covered with adherent scales, with densely spinoid scales above lateral line and low on side, intermediate scales cycloid, at least anteriorly (all but those above pectoral-fin base spinoid in small specimens, large specimens as with holotype); isthmus covered with fine spinoid scales; center of each lateral line scale without a distinct spine; deep serrated abdominal keel formed from enlarged scales (scutes) covered laterally all but along distal edge by normal body scales, anterior-most scute and those posteriorly with more than one apical tip, appearing as additional closely juxtaposed scutes (all scutes simple in juveniles); predorsal scales on dorsal midline slightly raised (more so in small individuals), their spinules not greatly enlarged. Dorsal fin spines progressively

longer posteriorly, greatest increases in length from first to third spine; posterior spines progressively thicker with prominent lengthwise striations (rather simple in juveniles, becoming broader and striations developing with growth); soft rays distinctly longer than last spine, first few nearly twice length of last spine, outer margin of soft dorsal fin nearly straight. Pectoral fin reaching base of anterior segmented anal fin rays. Pelvic fin to just beyond middle scutes (almost reaching anus in small specimens). Pyloric caeca unbranched.

Moderately small species, largest specimen examined 141 mm SL.

Pigmentation in alcohol. Uniformly pale; buccal and branchial chambers mostly pale, dusker towards back of mouth (almost uniformly pale in small specimens), underside of tongue uniformly pale.

Colour in life. Silver with metallic sheen, narrow strip dorsally on side adjacent dorsal fin base olivaceous; fins hyaline, pectoral and caudal fins with faint reddish to brownish hue; buccal and branchial chambers creamy to yellowish grey (fig. 1).

Etymology. The specific name *ravurictus*, from the Latin *ravus* meaning 'greyish yellow' and *rictus* 'open mouth', in reference to the pale buccal cavity of this species, which contrasts with the black lining of the mouth found in most other species of the subgenus *H. (Hoplostethus)*.

Distribution. Apparently confined to tropical latitudes of western Australia between about 10° and 20°S. Occurs at slope depths between about 250 and 1000 m, most specimens in collections coming from around 400 m.

Comments. Species of the subgenus *H. (Hoplostethus)* are relatively conservative morphologically, the characters employed by Kotlyar (1996) to distinguish between species mostly involving subtle differences in body form, numbers of pectoral fin rays, predorsal scales, abdominal scutes, gill rakers and pyloric caeca, scale form and details of colouration. *Hoplostethus ravurictus* is unique among currently recognised species in having a yellowish grey rather than black lining of the buccal cavity and branchial region. Unlike other Australian species, it also has the isthmus fully covered with spinoid scales. Although Kotlyar failed to comment on the latter character in diagnosing species, the isthmus appears to be naked in most, the sole exception seen during the course of this study being a species that occurs off southern Japan and northern Taiwan, treated in the literature as *H. crassispinus* Kotlyar 1986 (Yamakawa, in Okamura et al., 1982; Yamakawa, in Okamura, 1985; Mok, in Shen, 1993; Hyashi, in Nakabo, 2002). *Hoplostethus ravurictus* differs from the Australian *H. gigas*, *H. intermedius* and *H. latus* also in having more numerous abdominal scutes (10–20, rarely 10–12 or 17–20, versus 8–12, rarely 11 or 12). The affinities of *H. ravurictus* with described species are not clear as it fails to share diagnostic characters with any of them. Only *H. abramovi* (southwestern Indian Ocean), *H. crassispinus* (central North Pacific) and *H. rifti* (southwestern Indian Ocean) regularly have comparable numbers of abdominal scutes. All three of these have greater numbers of pectoral fin rays than *H. ravurictus* (16, versus 15,

rarely 13, 14 or 16) and black membranes between dorsal fin spines, while the first two have a deeper body and more curved predorsal profile.

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References

- Gloerfelt-Tarp, T. and Kailola, P.J. 1984. *Trawled Fishes of Southern Indonesia and Northwestern Australia*. Australian Develop. Assist. Bur., Directorate Gen. Fisheries, Indonesia and German Agency Tech. Coop. 406 pp; xvi, num. col. pls.
- Gomon, M.F., Glover, C.J.M. and Kuitert, R. H. (eds) 1994. *Fishes of Australia's South Coast*. Handbook of the Flora and Fauna of South Australia. State Print: South Australia. 997 pp.
- Kotlyar, A.N. 1996. *Beryciform fishes of the world ocean*. VNIRO Publishing, 368 pp. (Котляр А.Н. 1996. Бериксообразные рыбы Мирового океана. М.: Изд-во ВНИО, 368 с, in Russian).
- Leviton, A.E., Gibbs Jr., R.H., Heal E. and Dawson, C.E. 1985. Standards in herpetology and ichthyology: part 1. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985: 802–32.
- Nakabo, T. (ed.) 2002. *Fishes of Japan with pictorial keys to the species, English edition*. Fish. 2 vols. Tokai University Press: Tokyo. 1749 pp.
- Okamura, O. (ed.) 1985. *Fishes of the Okinawa Trough and the adjacent waters. Vol. 2. The intensive research of unexploited fishery resources on continental slopes*. Japan Fisheries Resource Conservation Association, Tokyo. Pp. 418–781; pls 206–418.
- Okamura, O., Amaoka, K. and Mitani, F. (eds) 1982. *Fishes of the Kyushu-Palau Ridge and Tosa Bay. The intensive research of unexploited fishery resources on continental slopes*. Japan Fisheries Resource Conservation Association, Tokyo. Fish. 435 pp.
- Roberts, C.D. 1993. Comparative morphology of spined scales and their phylogenetic significance in the Teleostei. *Bulletin of Marine Science* 52: 60–113.
- Sainsbury, K.J., Kailola, P.J. and Leyland, G. 1984. *Continental Shelf Fishes of Northern and North-Western Australia*. CSIRO Div. Fisheries Res.: Canberra. 375 pp.; num. col. pls.
- Shen, S.-C. (chief ed.) 1993. *Fishes of Taiwan*. National Taiwan University: Taipei. 956 pp.; 208 pls.